US011726430B2

(12) **United States Patent**
Furuichi

(10) **Patent No.: US 11,726,430 B2**
(45) **Date of Patent: *Aug. 15, 2023**

(54) **IMAGE FORMING APPARATUS**

(71) Applicant: **Yuusuke Furuichi**, Kanagawa (JP)

(72) Inventor: **Yuusuke Furuichi**, Kanagawa (JP)

(73) Assignee: **RICOH COMPANY, LTD.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **17/497,306**

(22) Filed: **Oct. 8, 2021**

(65) **Prior Publication Data**

US 2022/0043391 A1 Feb. 10, 2022

Related U.S. Application Data

(63) Continuation of application No. 16/942,072, filed on Jul. 29, 2020, now Pat. No. 11,163,264.

(30) **Foreign Application Priority Data**

Aug. 8, 2019 (JP) 2019-146406
Aug. 16, 2019 (JP) 2019-149354
(Continued)

(51) **Int. Cl.**
G03G 15/20 (2006.01)
G03G 21/20 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 21/206*** (2013.01); ***G03G 15/2017*** (2013.01); ***G03G 15/2039*** (2013.01); ***G03G 15/2053*** (2013.01)

(58) **Field of Classification Search**
CPC G03G 15/2017; G03G 15/2053; G03G 21/20; G03G 21/206
See application file for complete search history.

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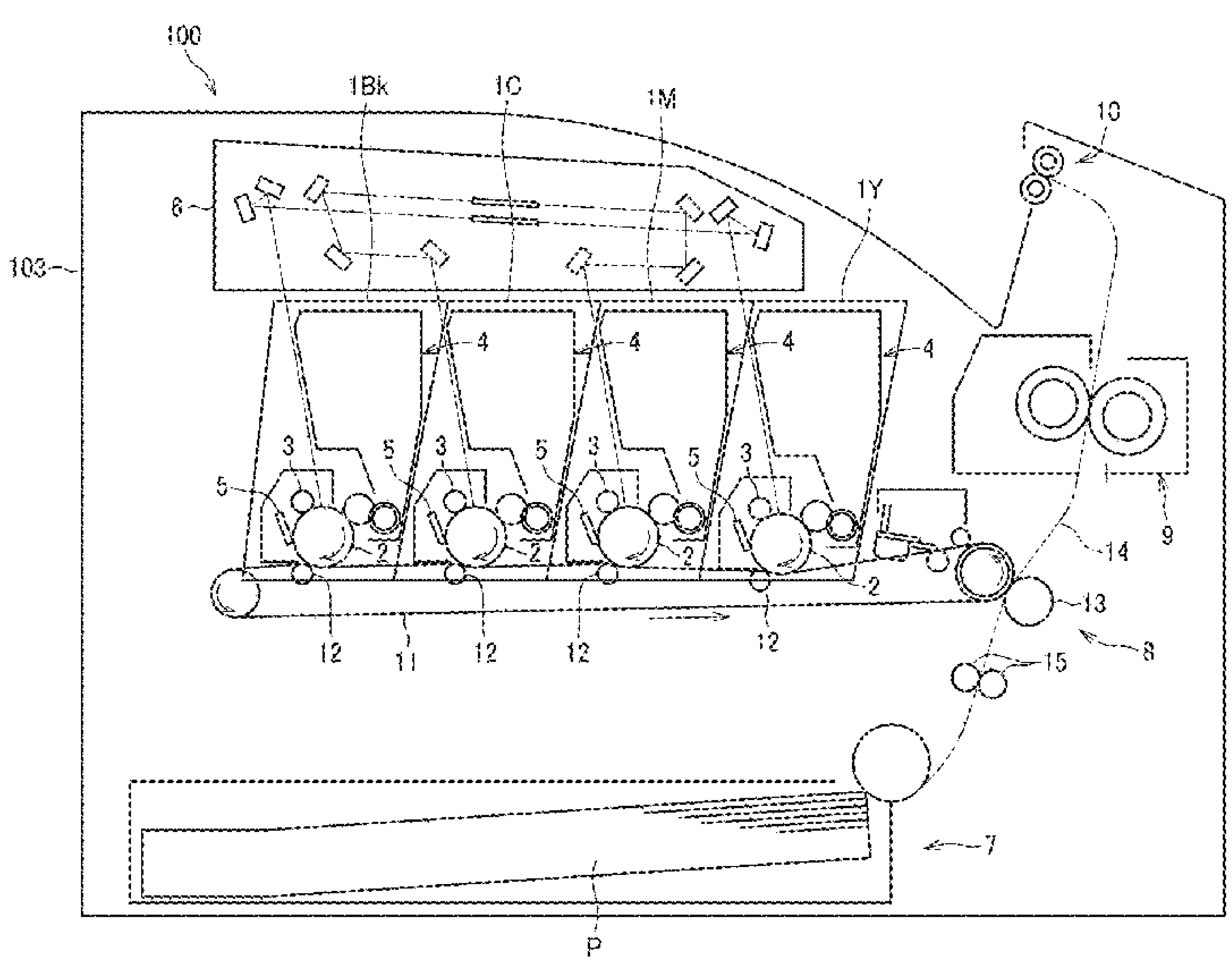
Primary Examiner — Thomas S Giampaolo, II
(74) *Attorney, Agent, or Firm* — Harness, Dickey & Pierce, P.L.C.

(57) **ABSTRACT**

An image forming apparatus includes a cooler and a heater. The heater includes a heat generation unit, which includes resistive heat generators arranged in a longitudinal direction of the heater, a first electrode, a second electrode, a first conductor that connects the resistive heat generators in parallel with each other to the first electrode, and a second conductor that connects the resistive heat generators in parallel with each other to the second electrode. The first and second conductors are connected to at least one of the resistive heat generators on a first longitudinal end side of the heater from a center of the resistive heat generator in the longitudinal direction of the heater. A cooling ability of the cooler to a second longitudinal end side of the heater opposite the first longitudinal end side of the heater is greater than that to the first longitudinal end side of the heater.

16 Claims, 19 Drawing Sheets



(30) **Foreign Application Priority Data**

Mar. 2, 2020	(JP)	2020-034912
Mar. 31, 2020	(JP)	2020-063726

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Chinese Notice of Allowance dated Apr. 20, 2023 for corresponding Chinese Patent Application No. CN202010776351.7.

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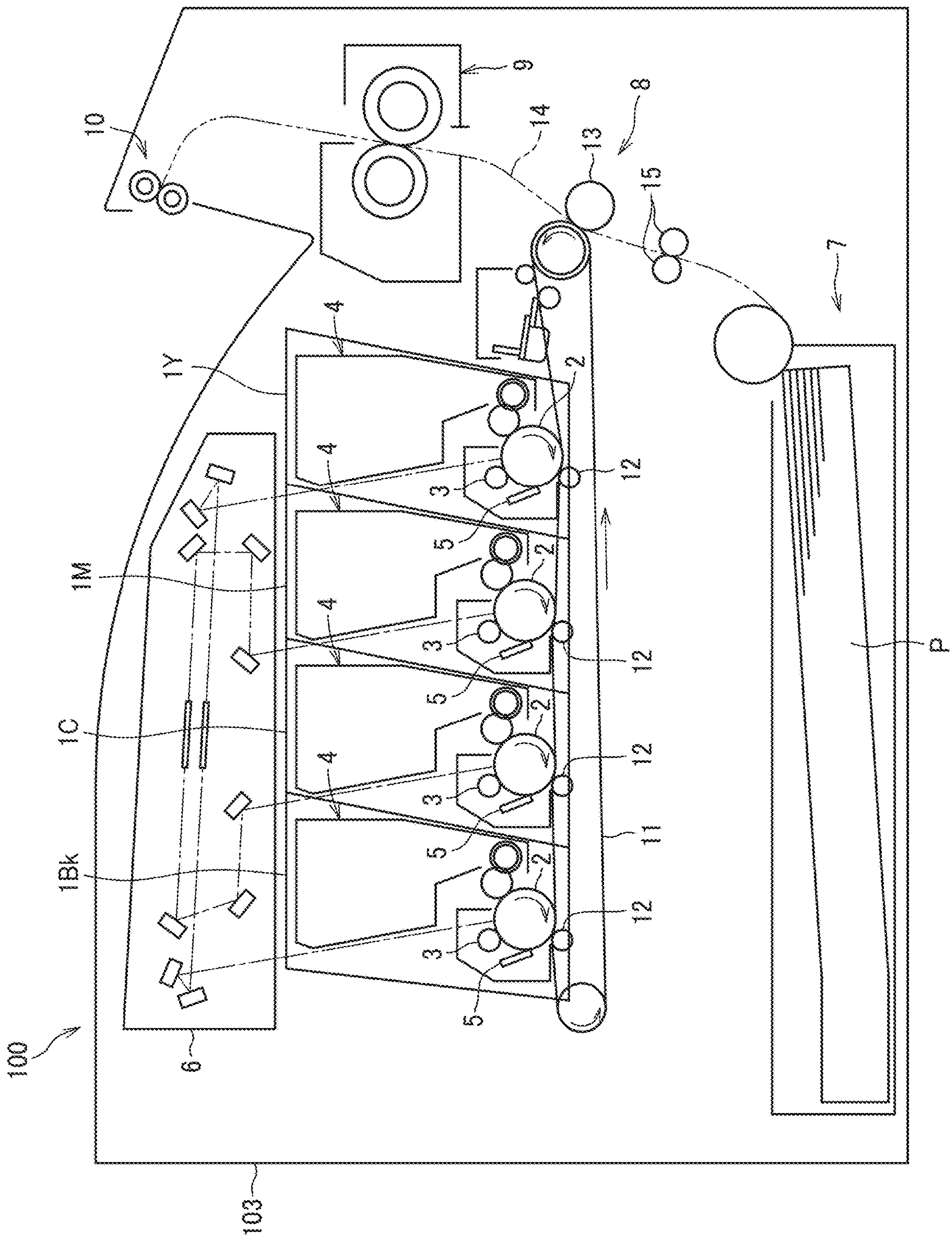


FIG. 1

FIG. 2

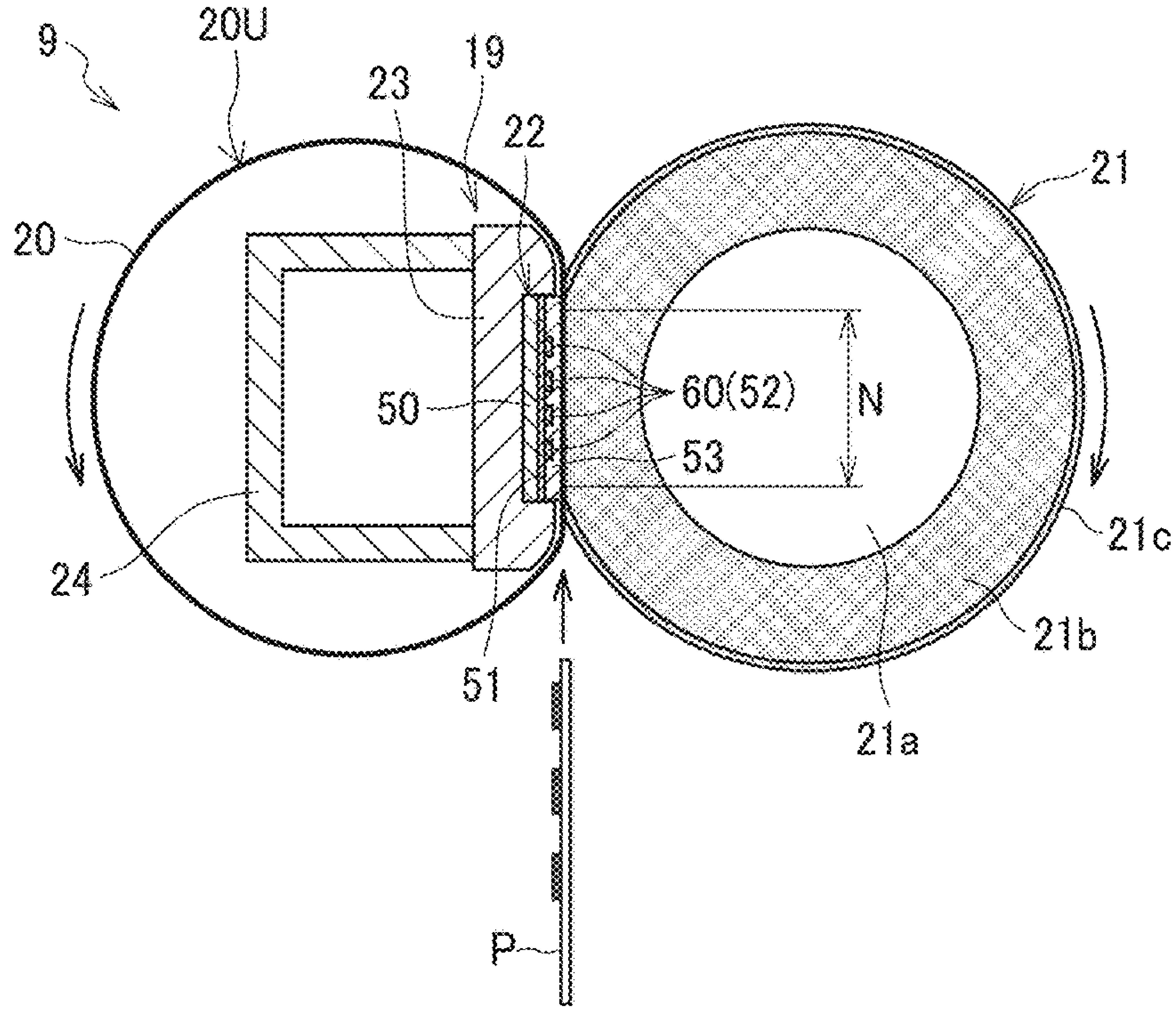

9
20U
19
23
22
21
20
50
60(52)
N
53
24
21c
51
21b
21a
P

FIG. 3

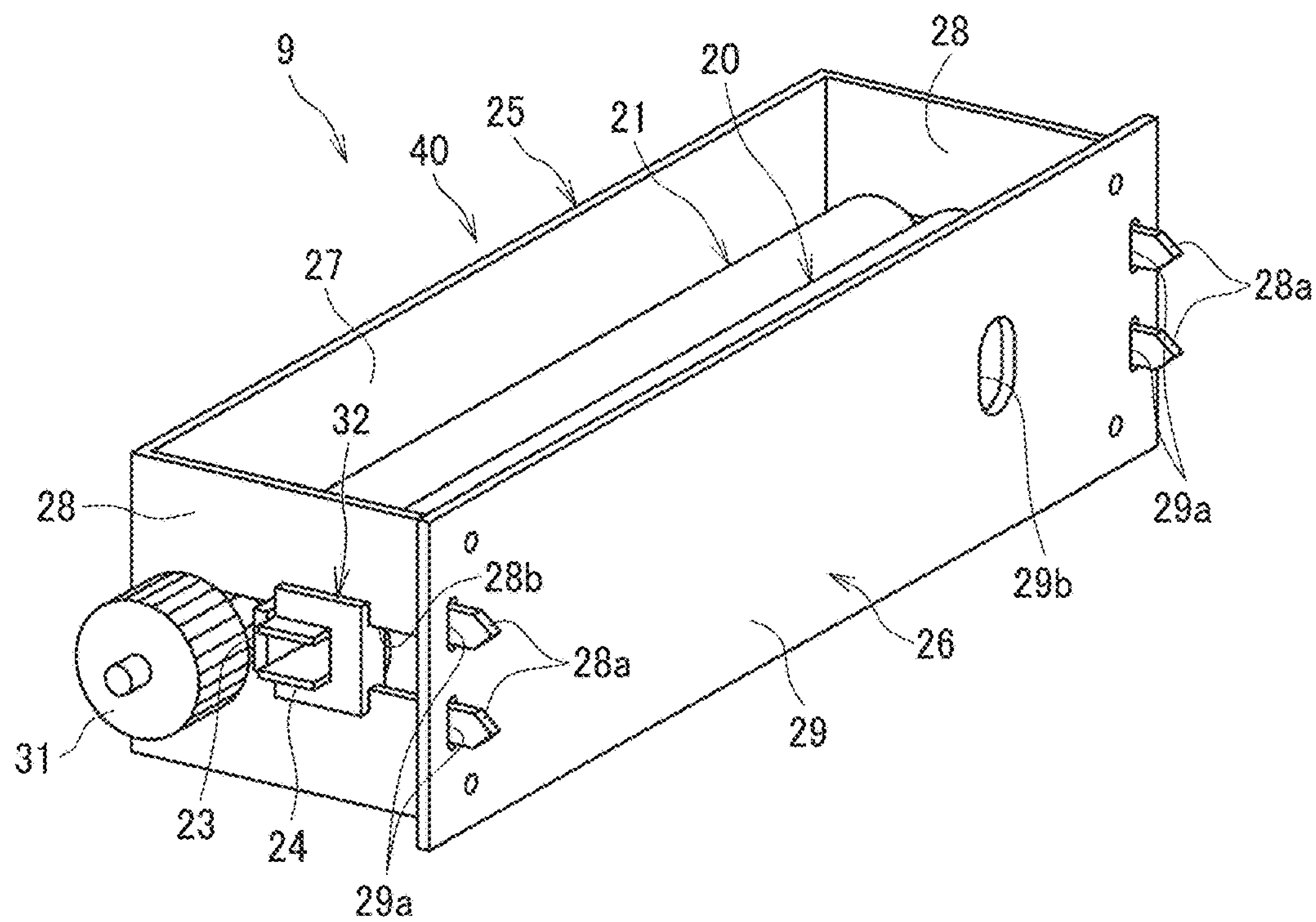
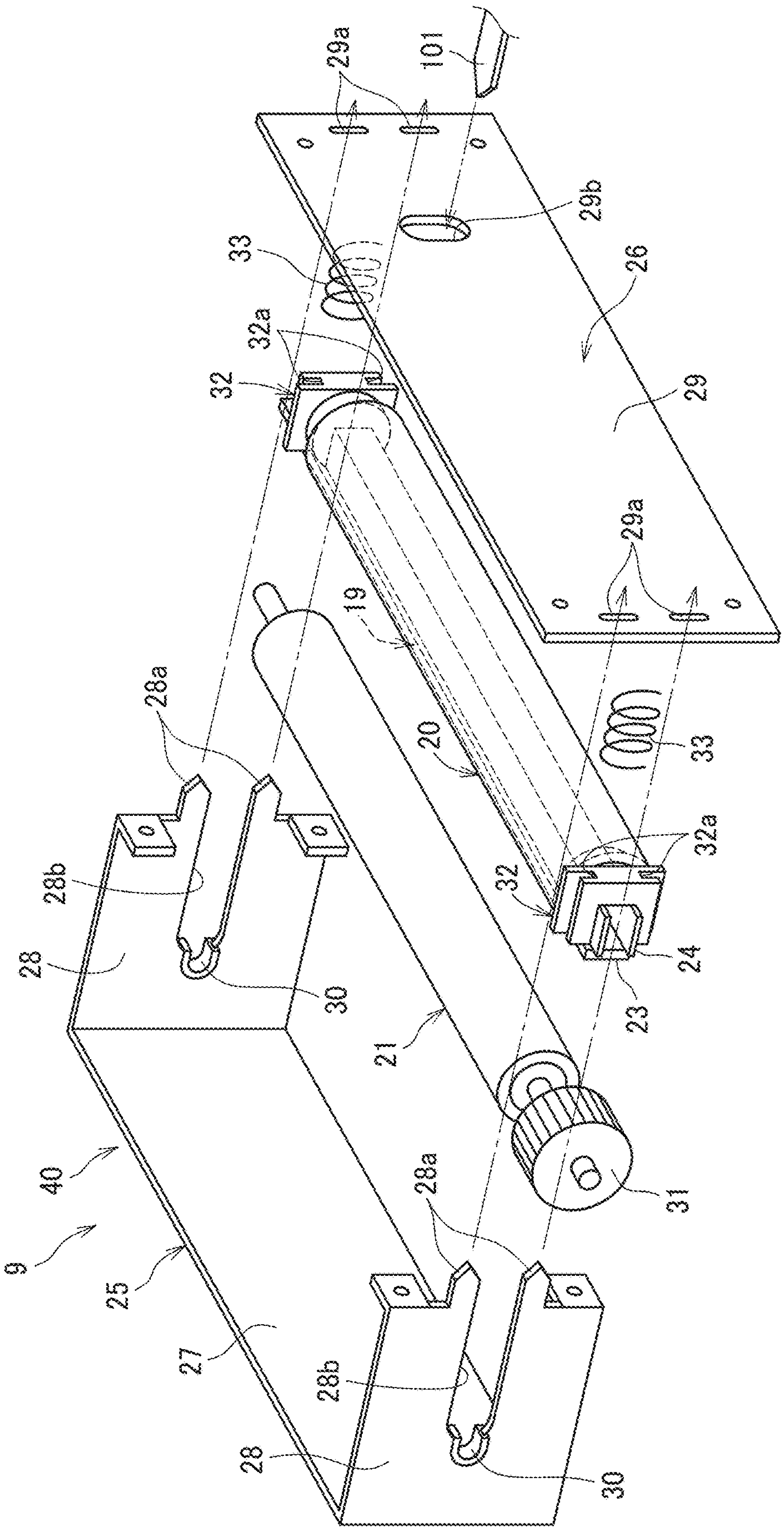

9
28
20
25
21
40
28a
27
32
29a
28
28b
29b
26
28a
31
29
23
24
29a

FIG. 4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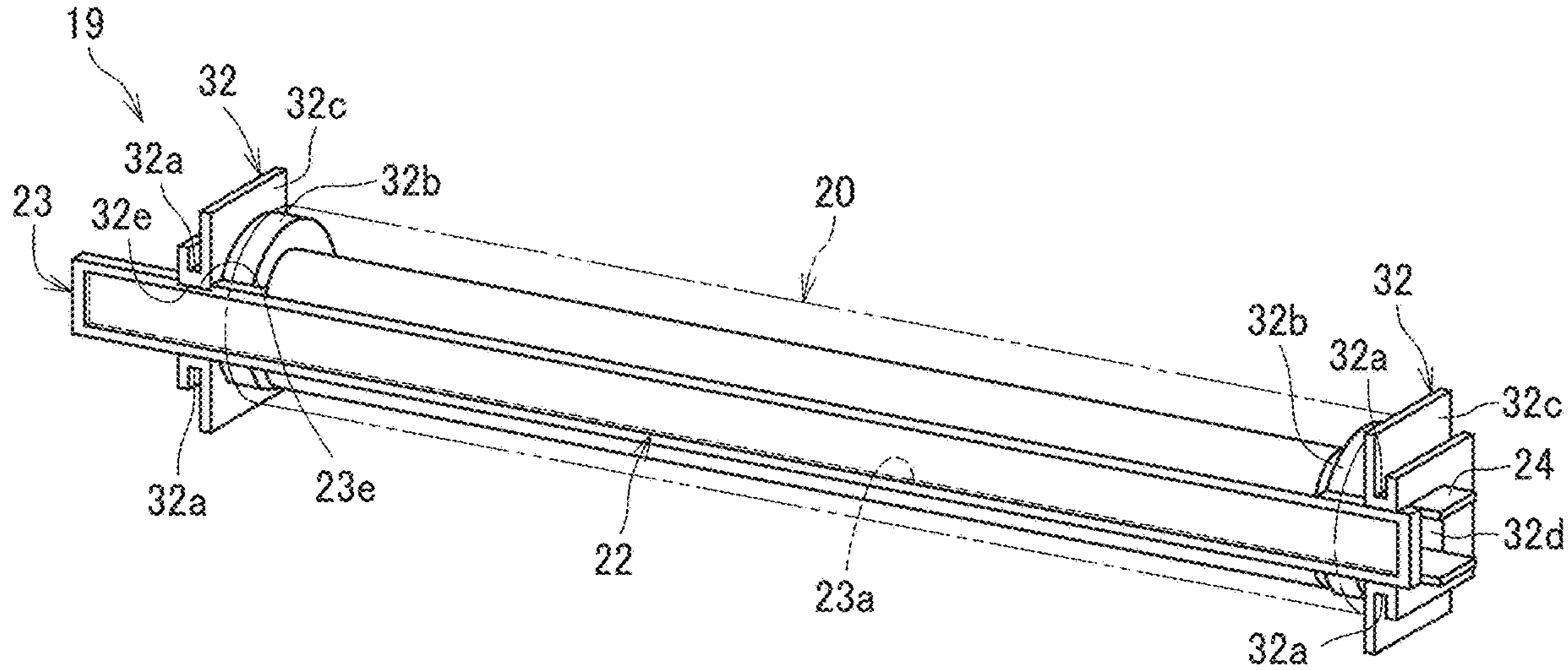
101
29b
26
29
33
32a
32
19
20
21
28a
28b
28
30
33
32a
32
24
23
31
40
9
25
27
28a
28b
28
30

FIG. 5


19
32
32c
32a
32b
23
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32
32b
32a
32c
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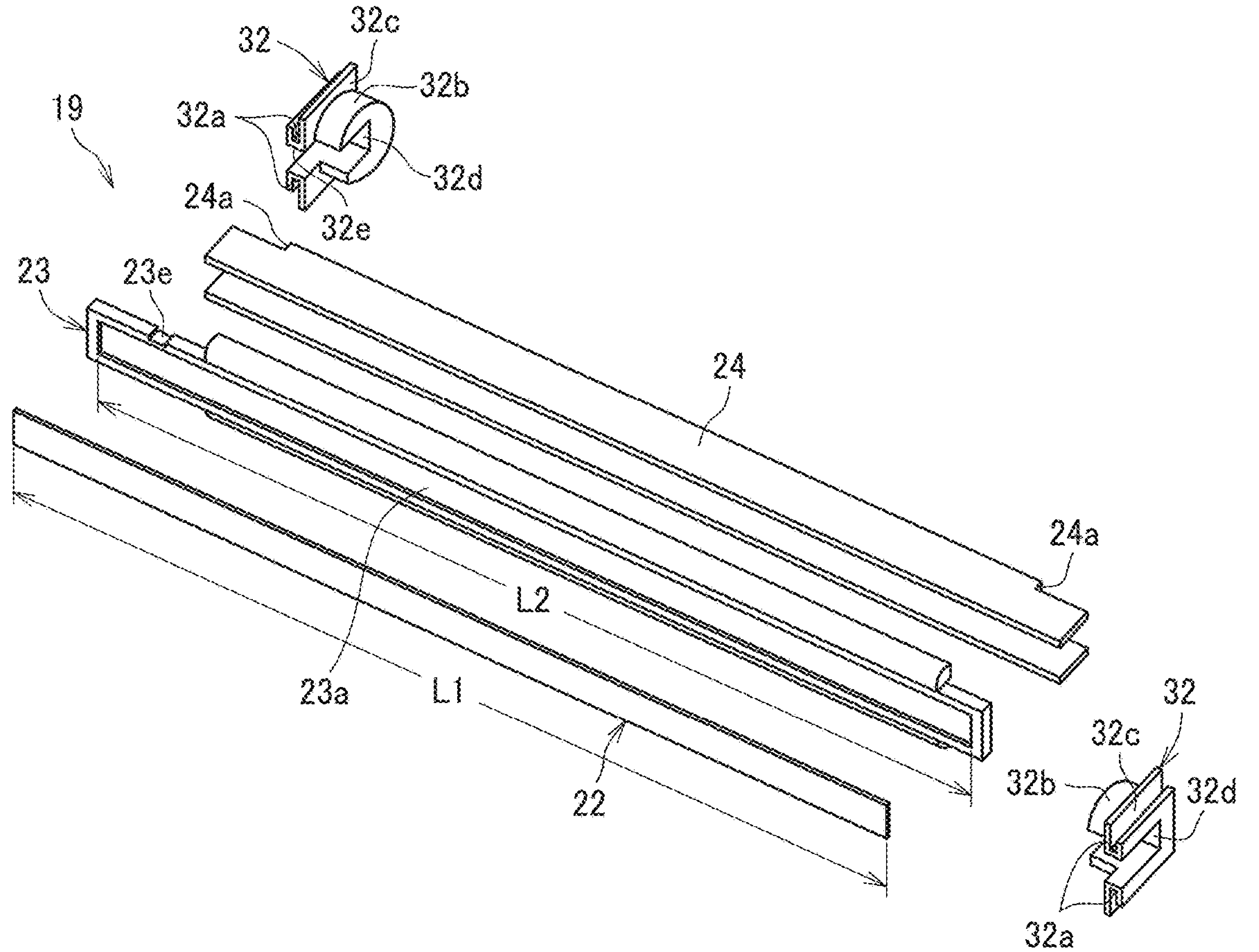
32d
32a
23e
22
23a
32a

FIG. 6


32
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32b
19
32a
32d
24a
32e
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23e
24
24a
L2
23a
L1
32
32c
32b
32d
22
32a

FIG. 7

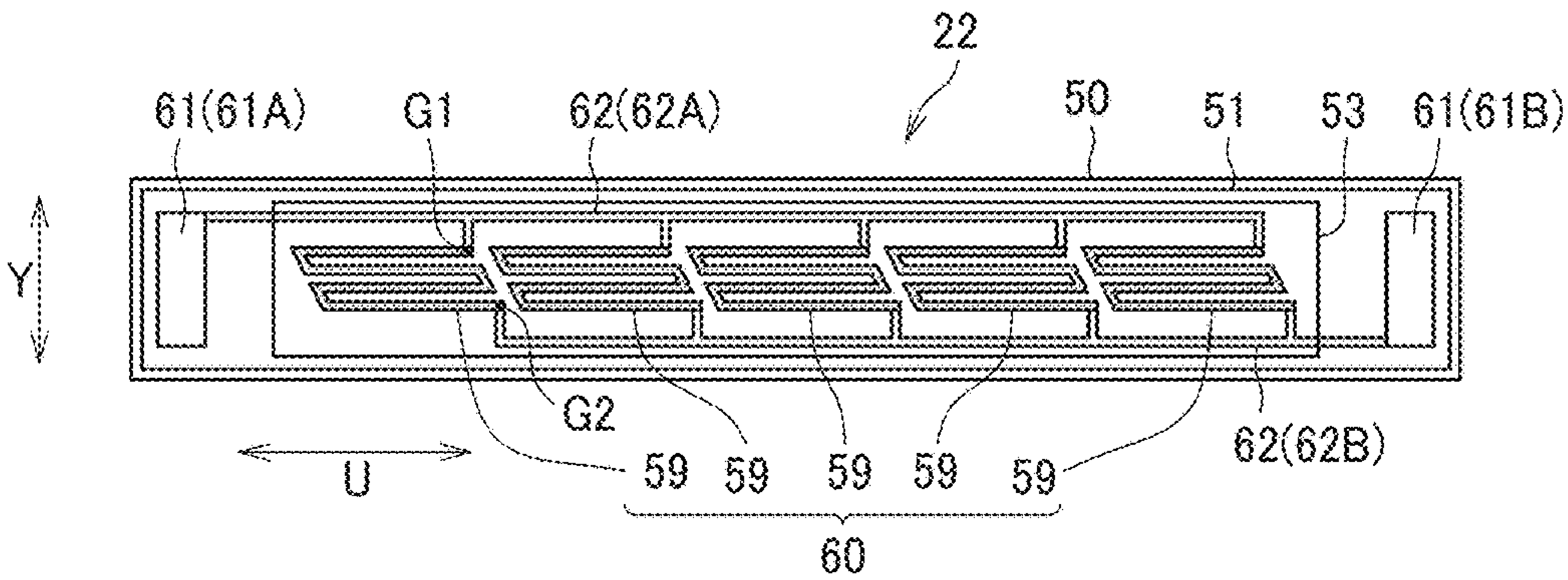


FIG. 8

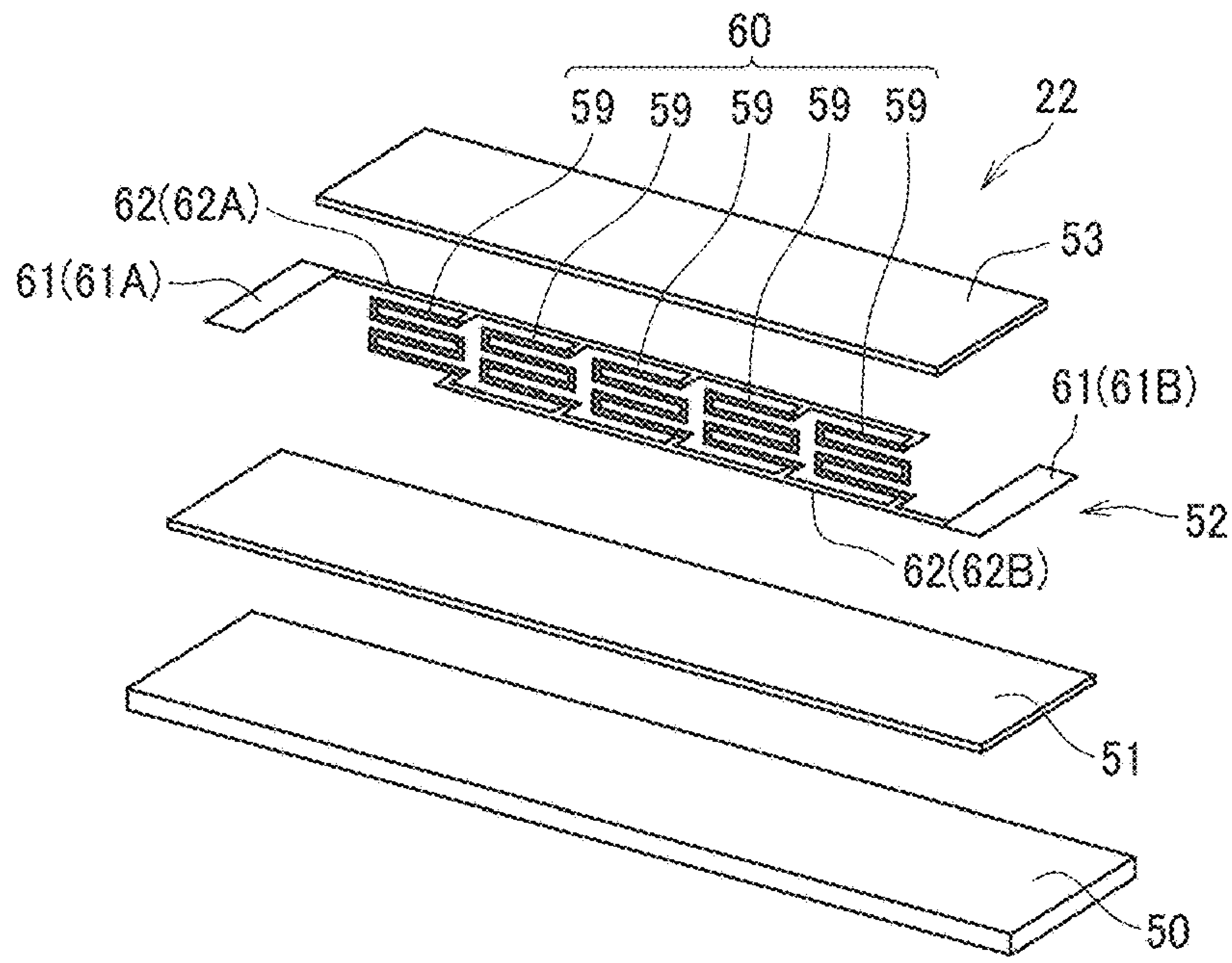


FIG. 9

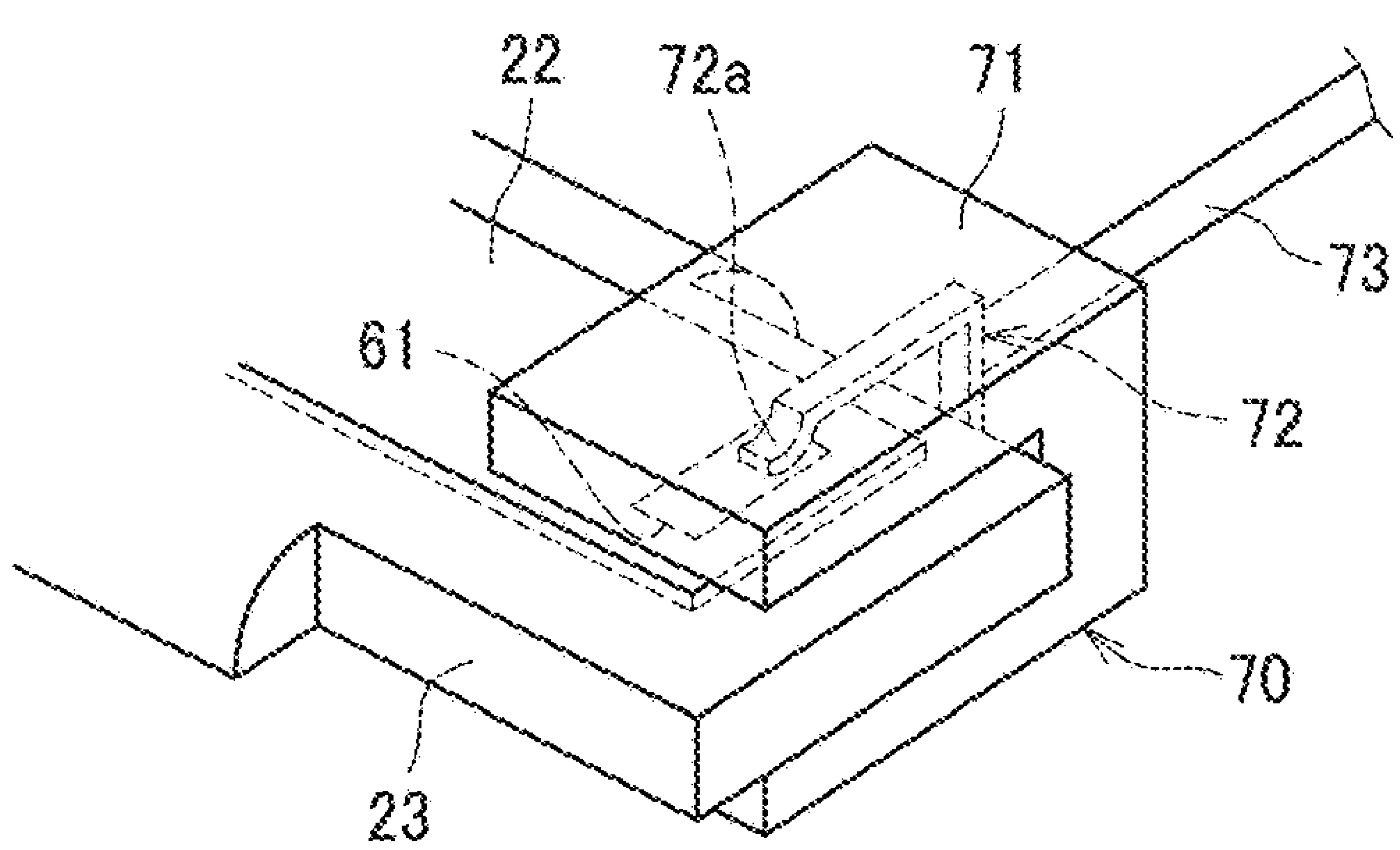
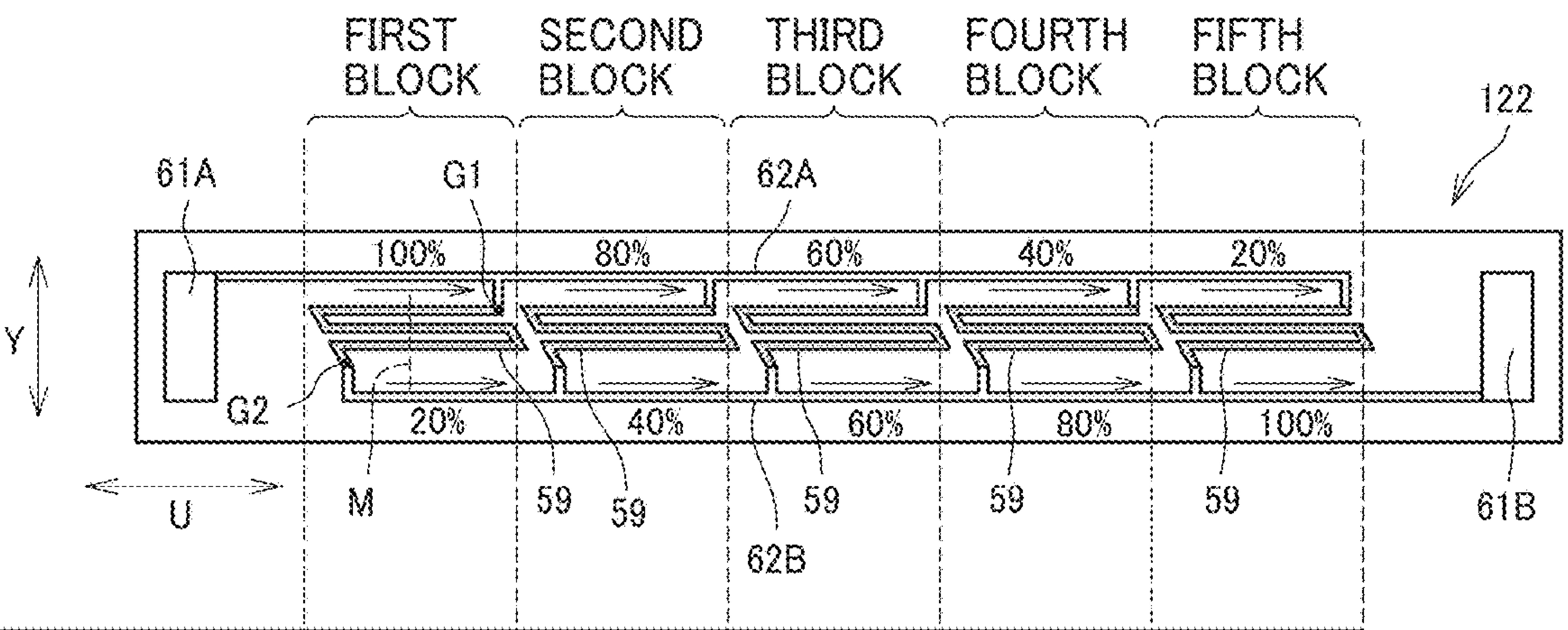


FIG. 10A



	FIRST BLOCK	SECOND BLOCK	THIRD BLOCK	FOURTH BLOCK	FIFTH BLOCK
AMOUNT OF HEAT GENERATED BY FIRST FEED LINE 62A	10000	6400	3600	1600	400
AMOUNT OF HEAT GENERATED BY SECOND FEED LINE 62B	400	1600	3600	6400	10000
TOTAL AMOUNT OF HEAT GENERATED	10400	8000	7200	8000	10400

FIG. 10B

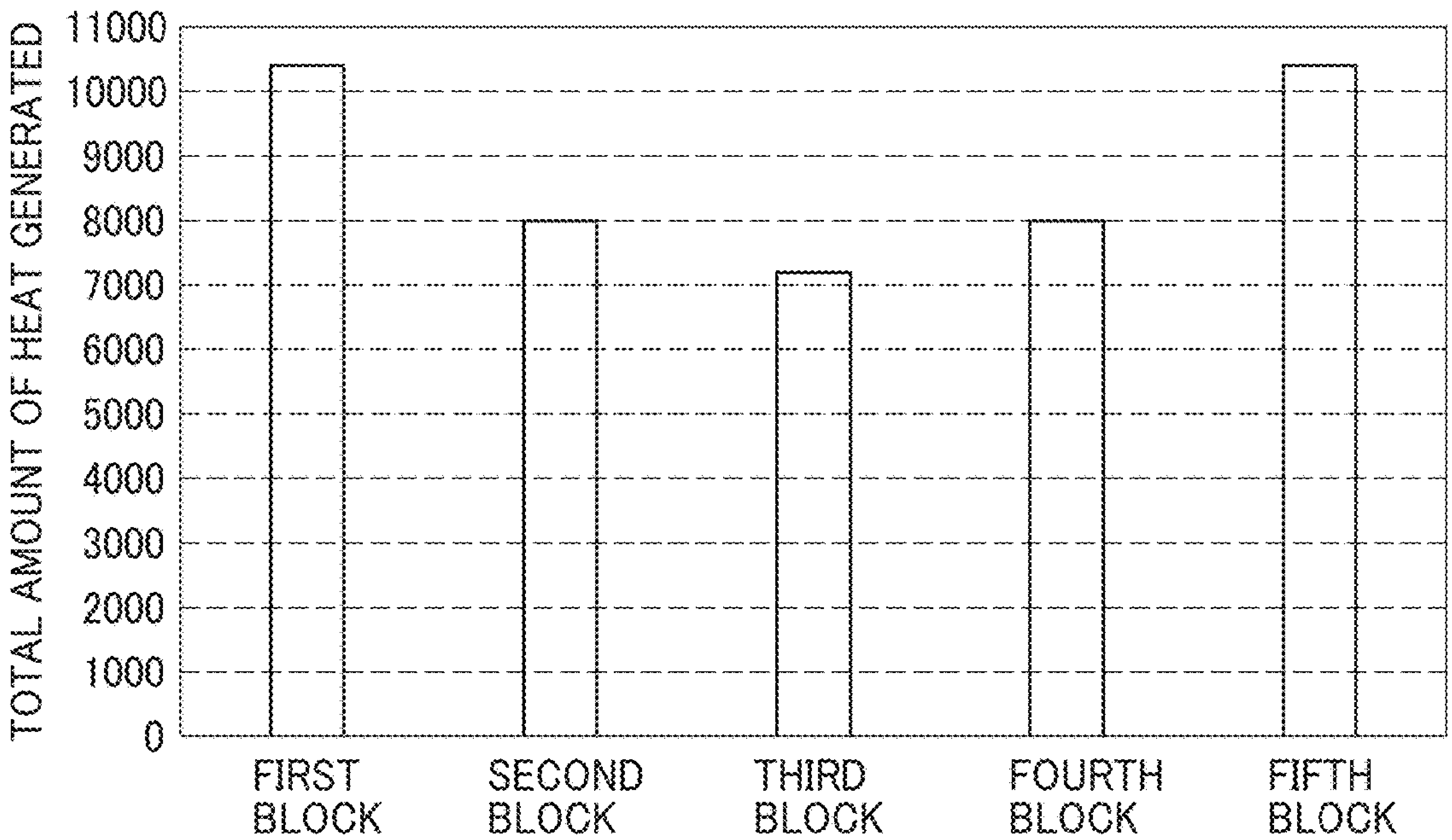
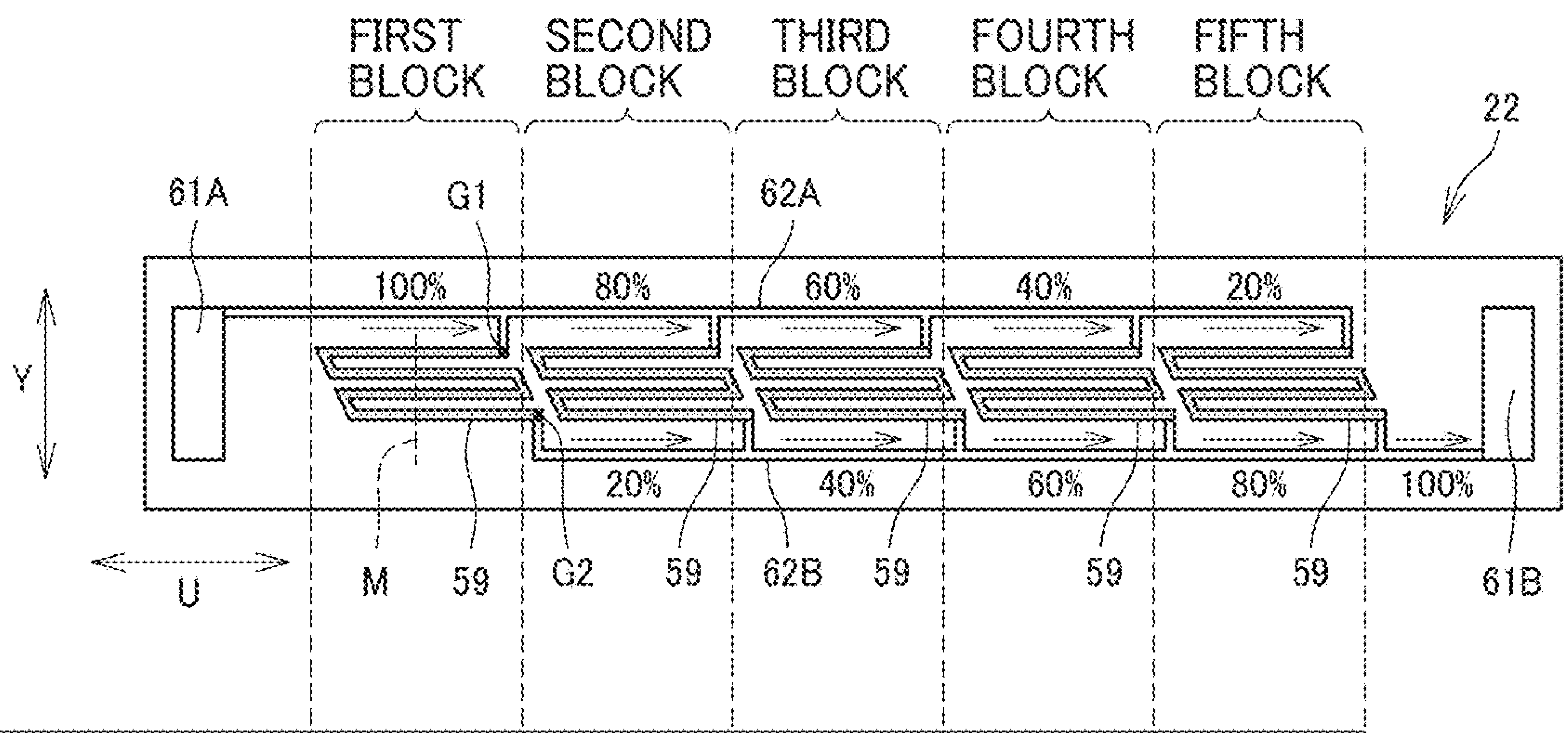


FIG. 11A



	FIRST BLOCK	SECOND BLOCK	THIRD BLOCK	FOURTH BLOCK	FIFTH BLOCK
AMOUNT OF HEAT GENERATED BY FIRST FEED LINE 62A	10000	6400	3600	1600	400
AMOUNT OF HEAT GENERATED BY SECOND FEED LINE 62B	—	400	1600	3600	6400
TOTAL AMOUNT OF HEAT GENERATED	10000	6800	5200	5200	6800

FIG. 11B

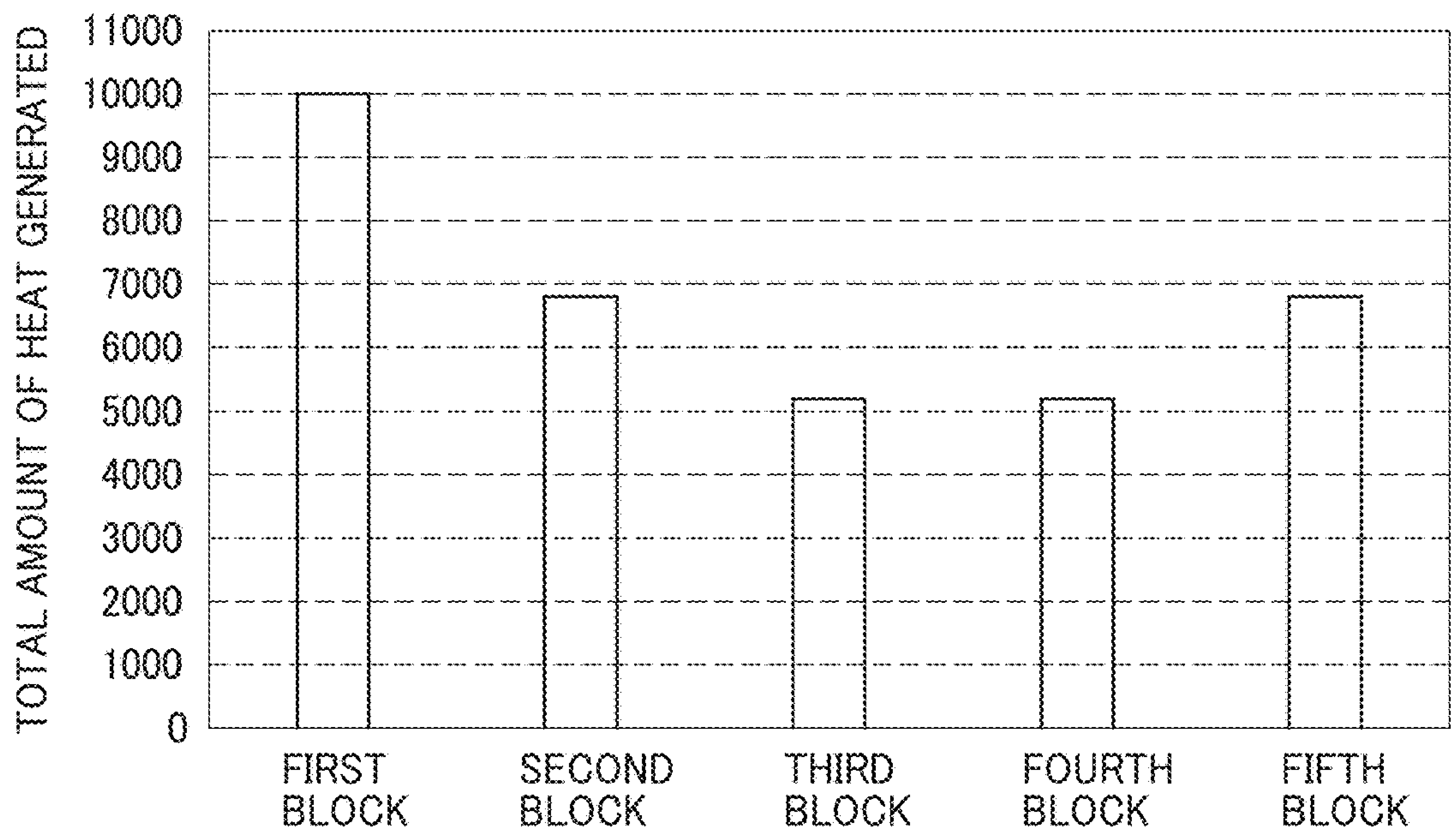


FIG. 12

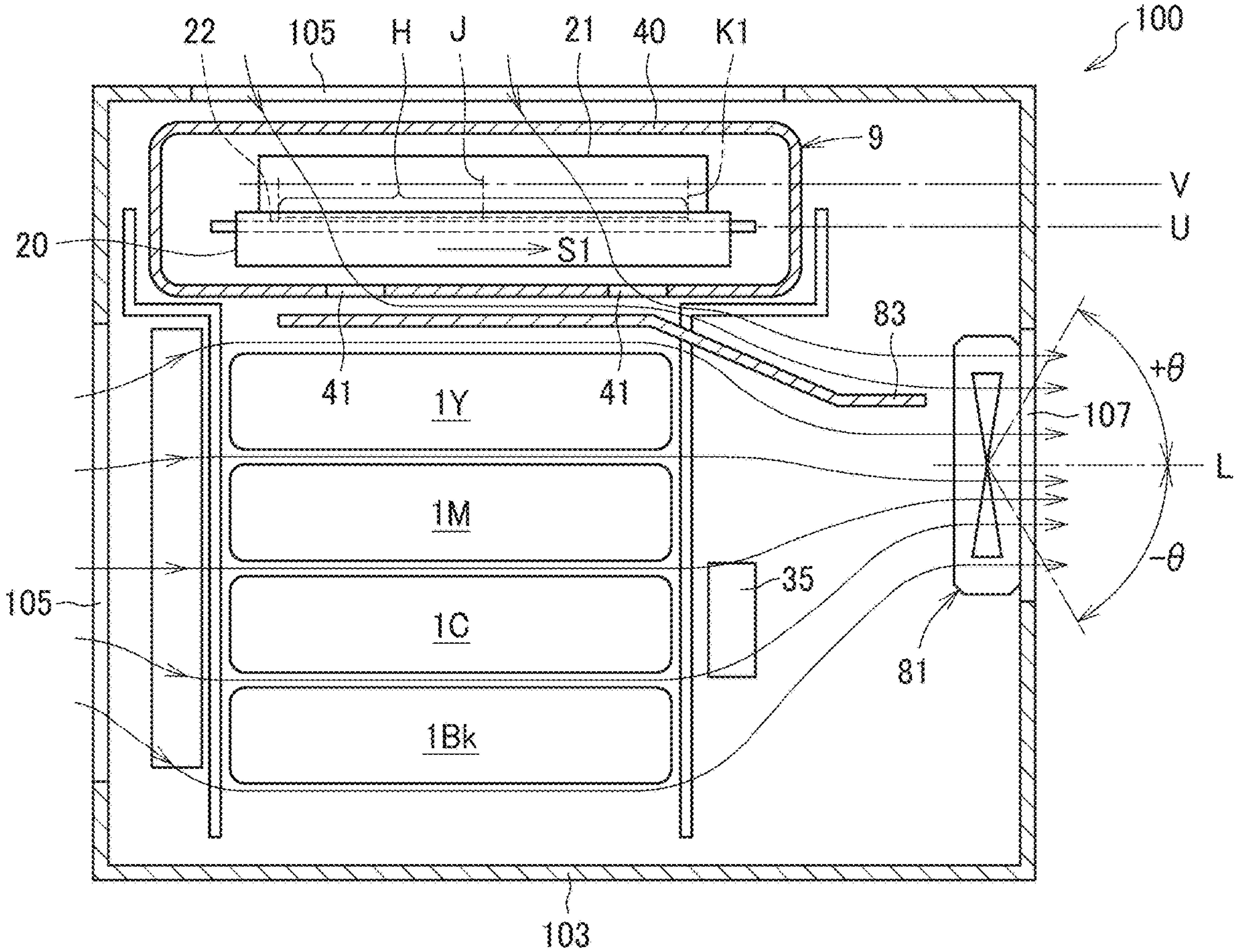
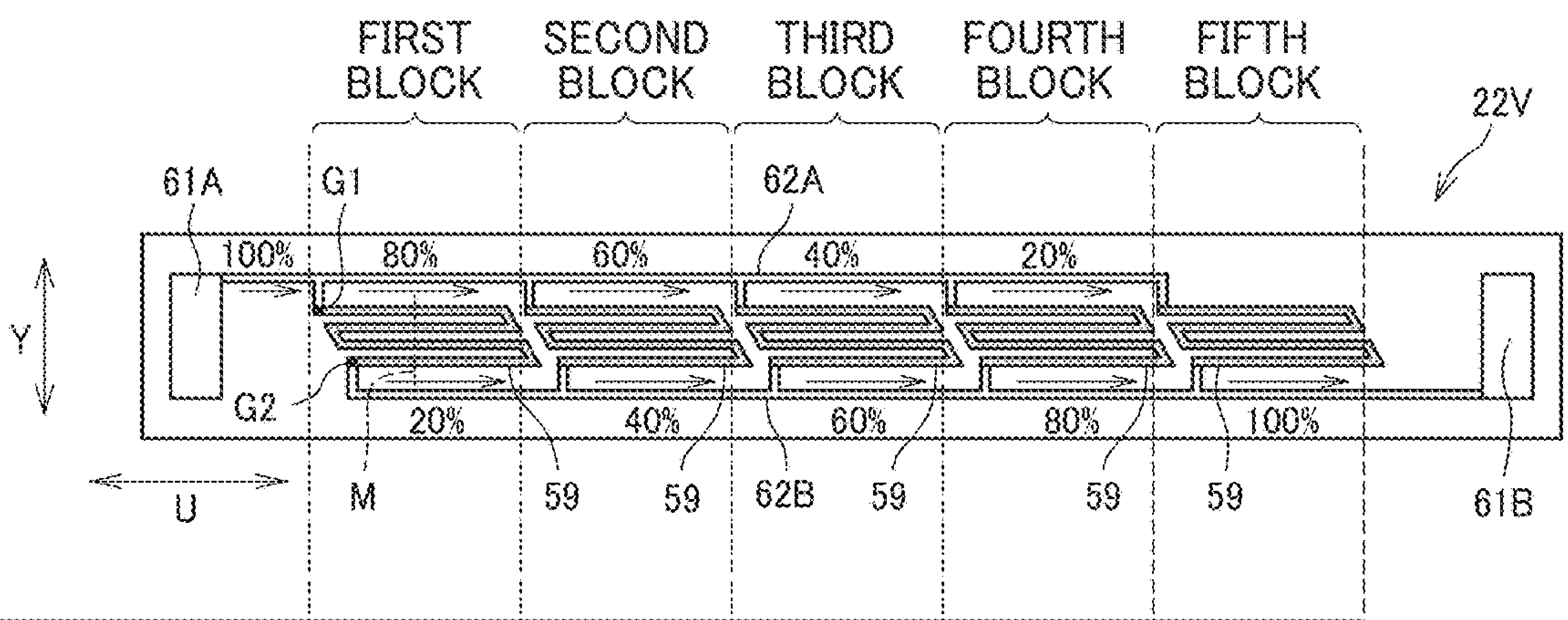

100
22
105
H
J
21
40
K1
9
V
U
20
S1
83
41
41
1Y
+θ
107
L
1M
35
-θ
105
1C
81
1Bk
103

FIG. 13A



	FIRST BLOCK	SECOND BLOCK	THIRD BLOCK	FOURTH BLOCK	FIFTH BLOCK
AMOUNT OF HEAT GENERATED BY FIRST FEED LINE 62A	6400	3600	1600	400	—
AMOUNT OF HEAT GENERATED BY SECOND FEED LINE 62B	400	1600	3600	6400	10000
TOTAL AMOUNT OF HEAT GENERATED	6800	5200	5200	6800	10000

FIG. 13B

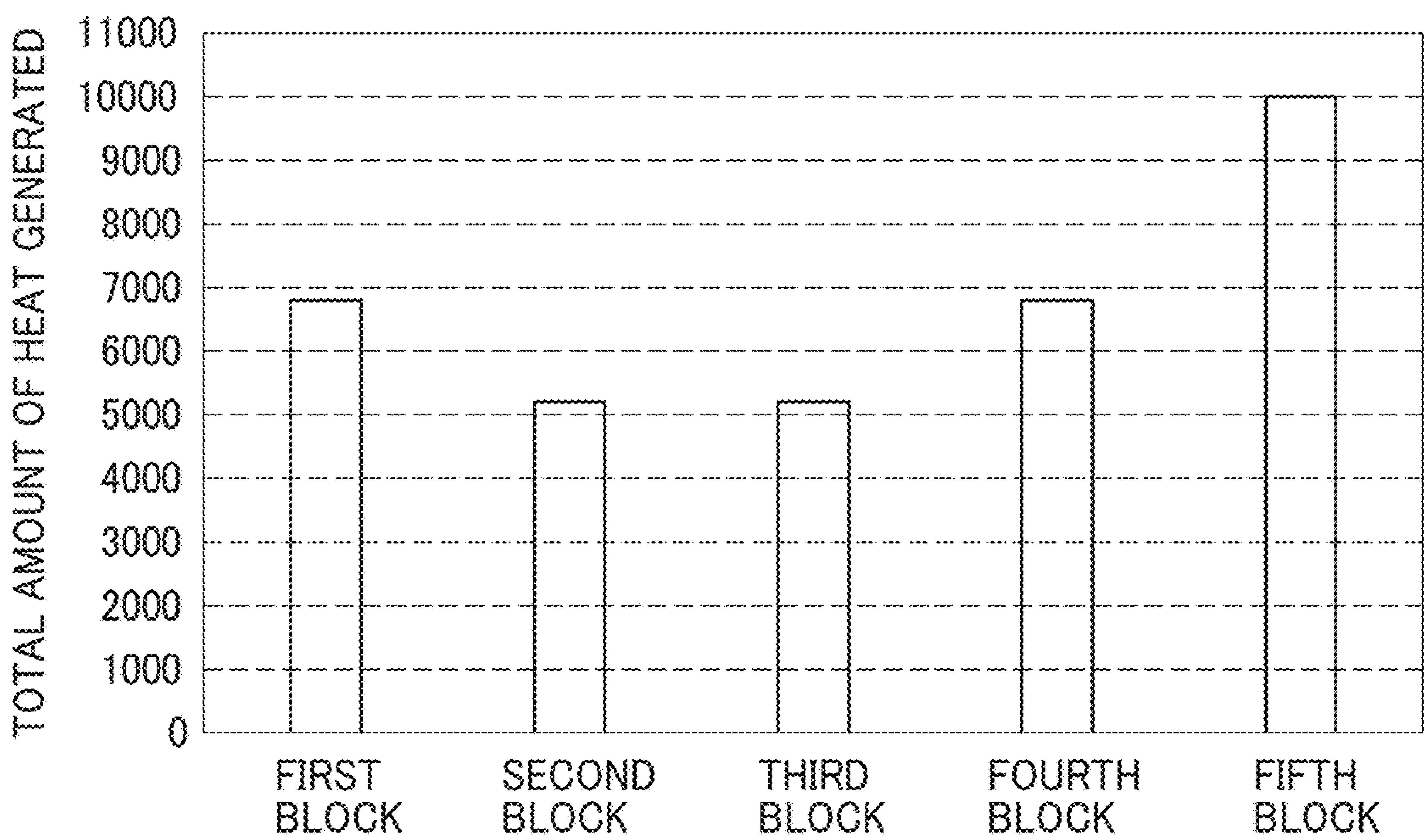


FIG. 14

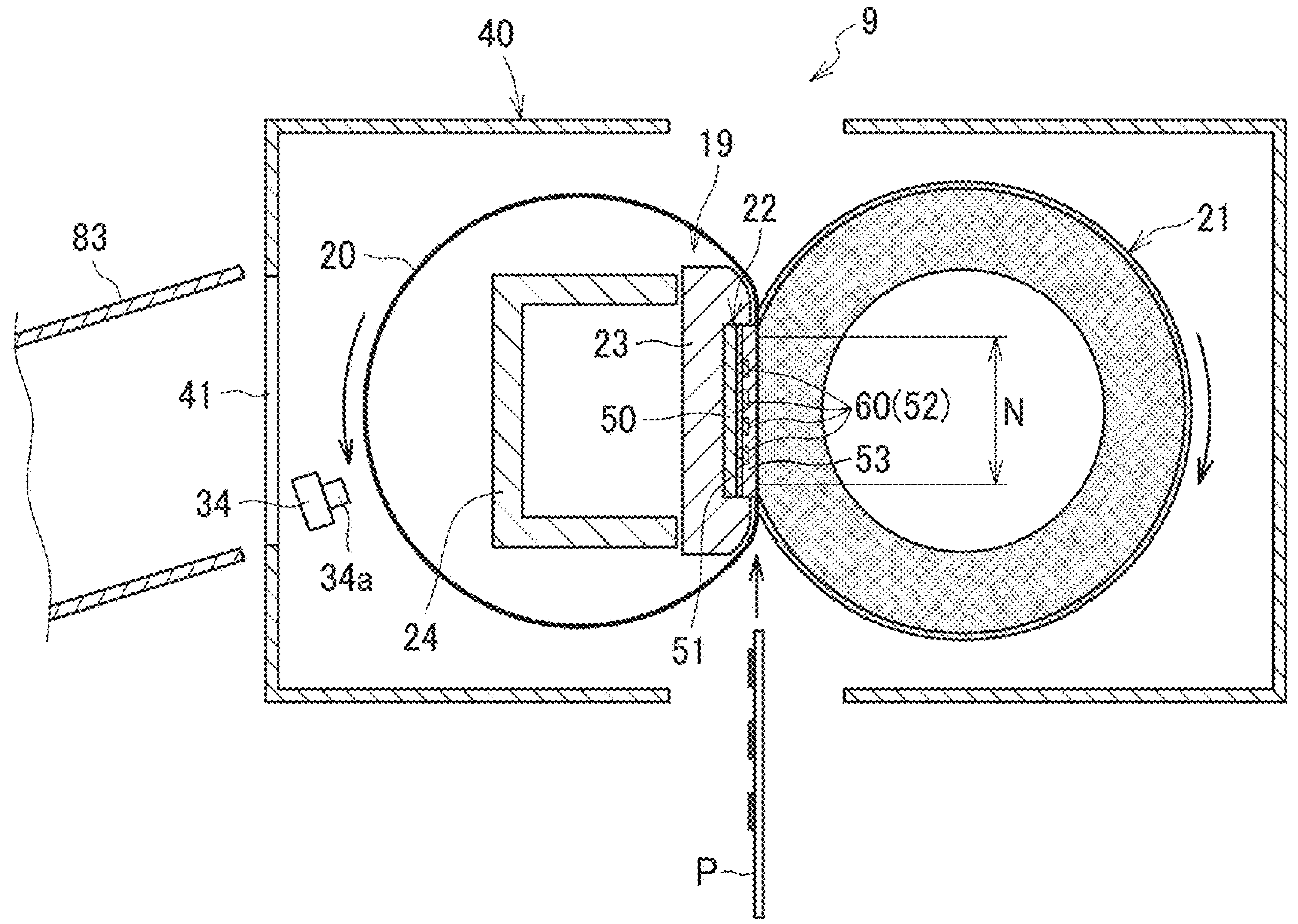
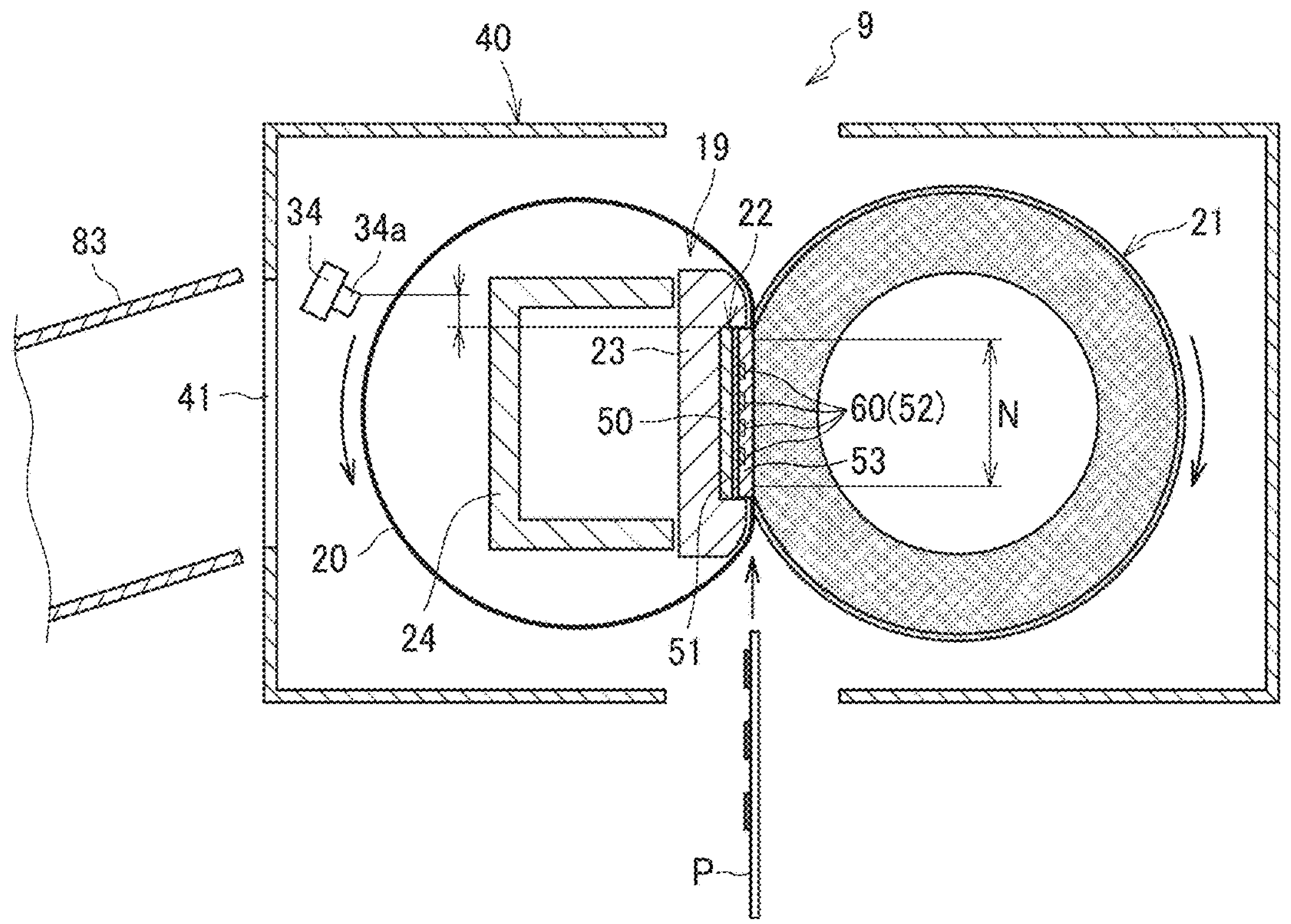

40
9
19
22
21
83
20
23
41
50
60(52)
N
53
34
34a
24
51
P

FIG. 15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21
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34a
83
23
41
50
60(52)
N
53
20
24
51
P

FIG. 16

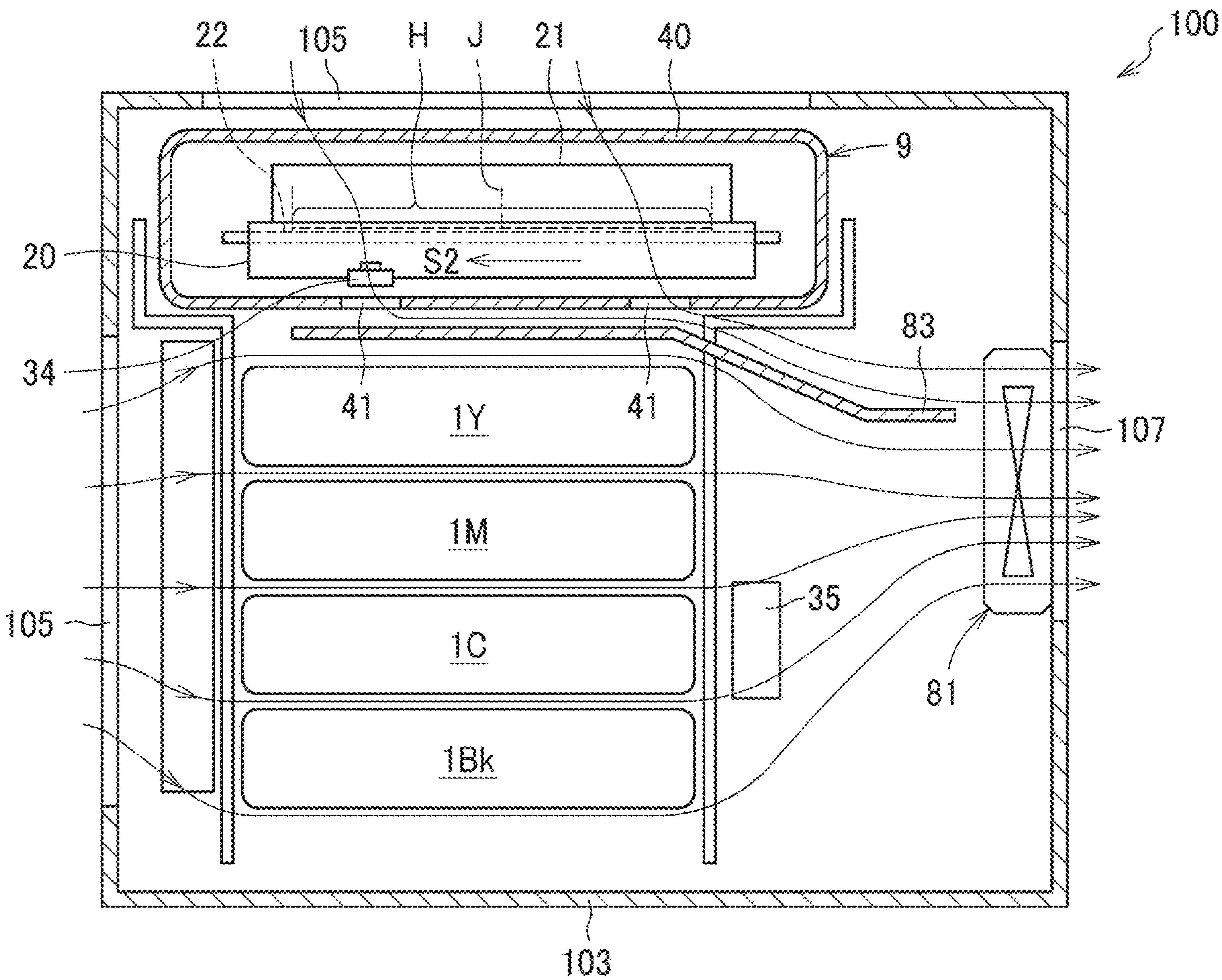


FIG. 17

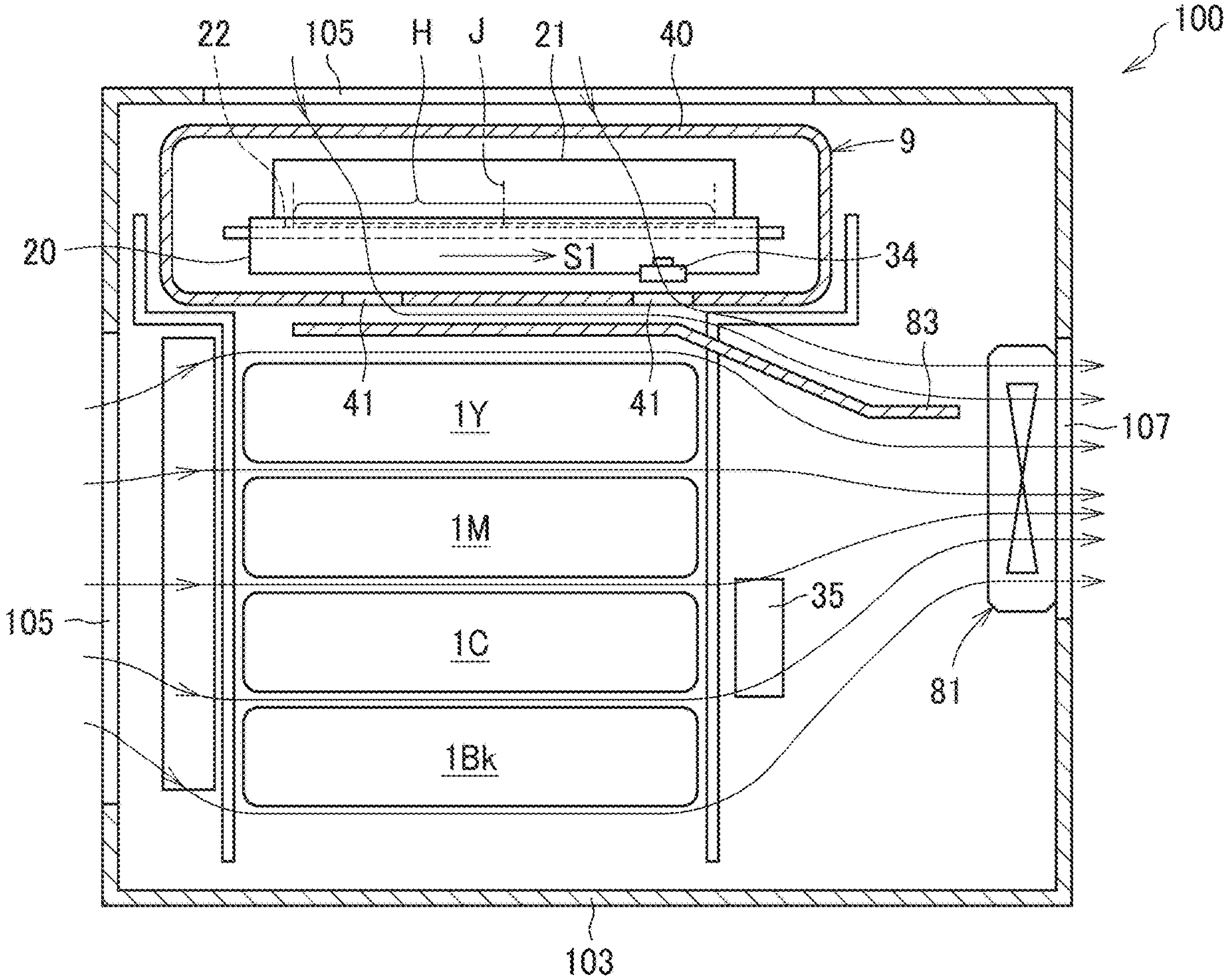


FIG. 18

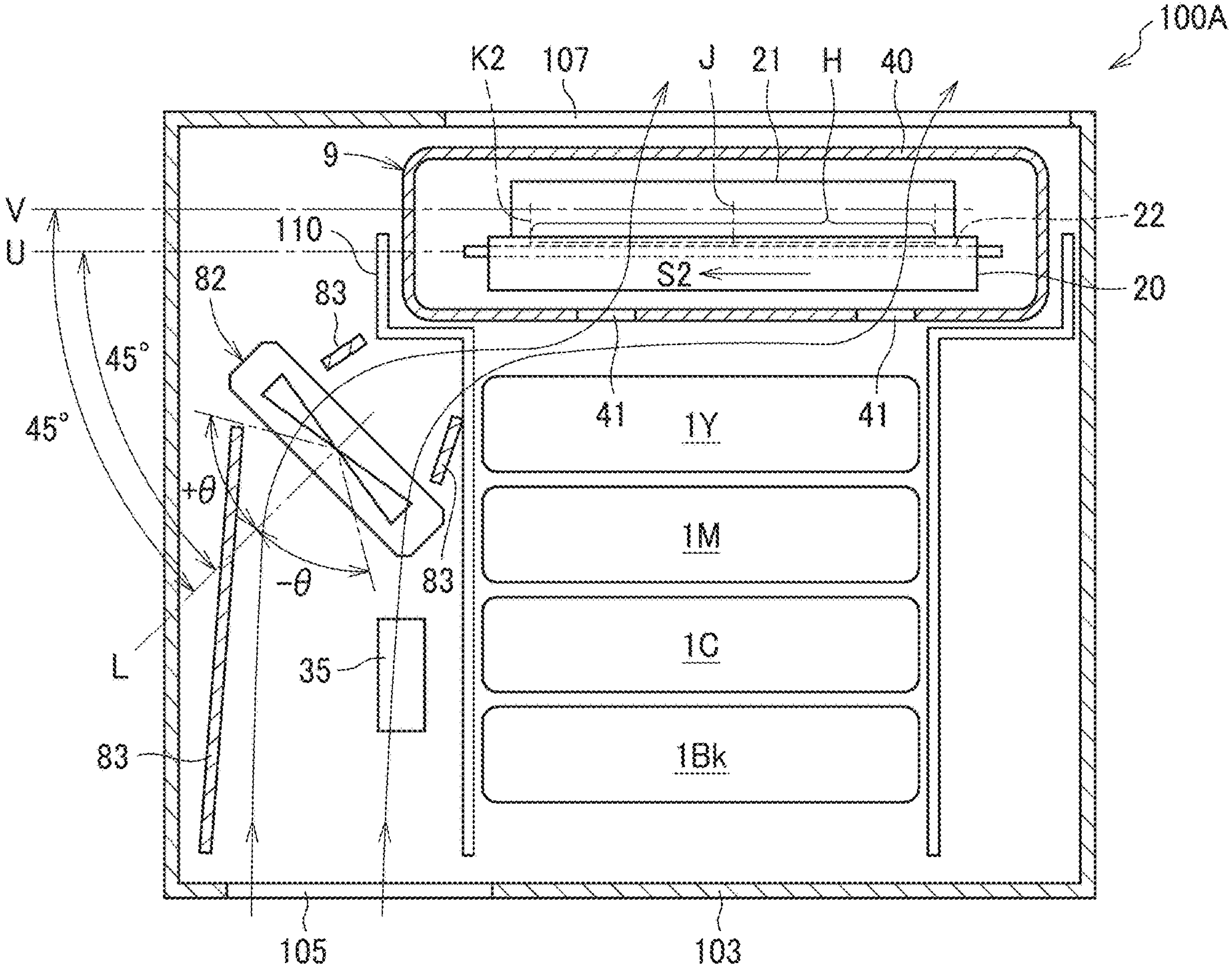
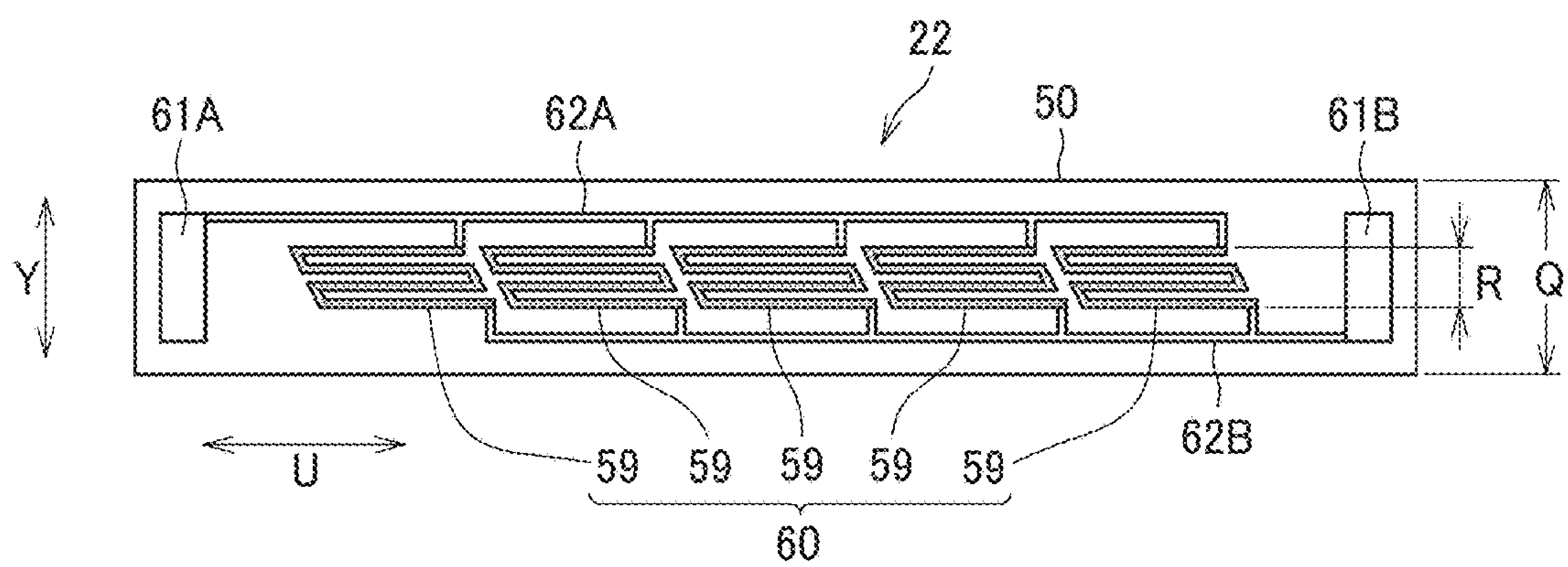

100A
K2
107
J
21
H
40
9
V
U
110
22
S2
20
82
83
45°
45°
41
41
1Y
+θ
−θ
83
1M
L
35
1C
83
1Bk
105
103

FIG. 19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62A
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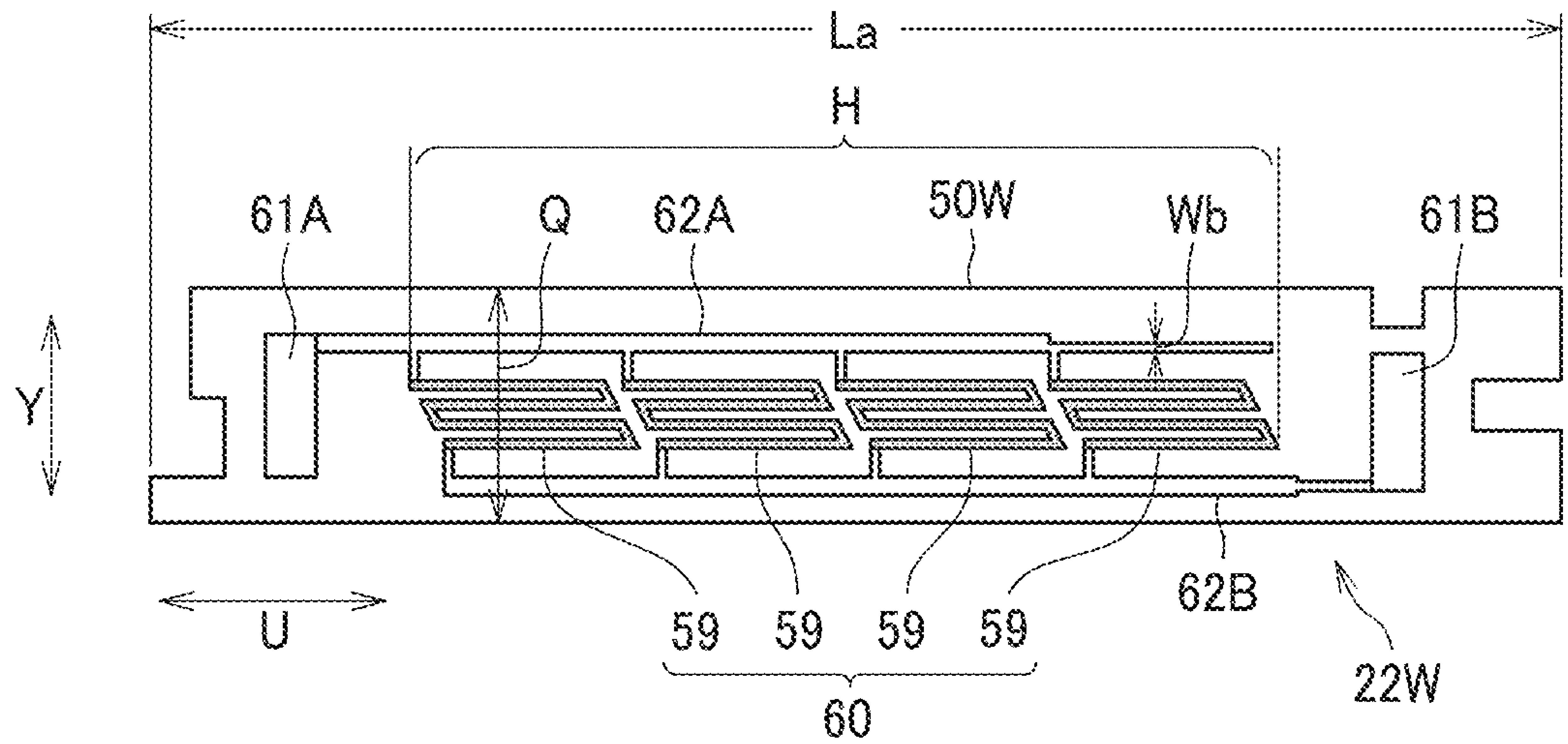
61B
Y
R
Q
U
59
59
59
59
59
62B
60

FIG. 20


La
H
61A
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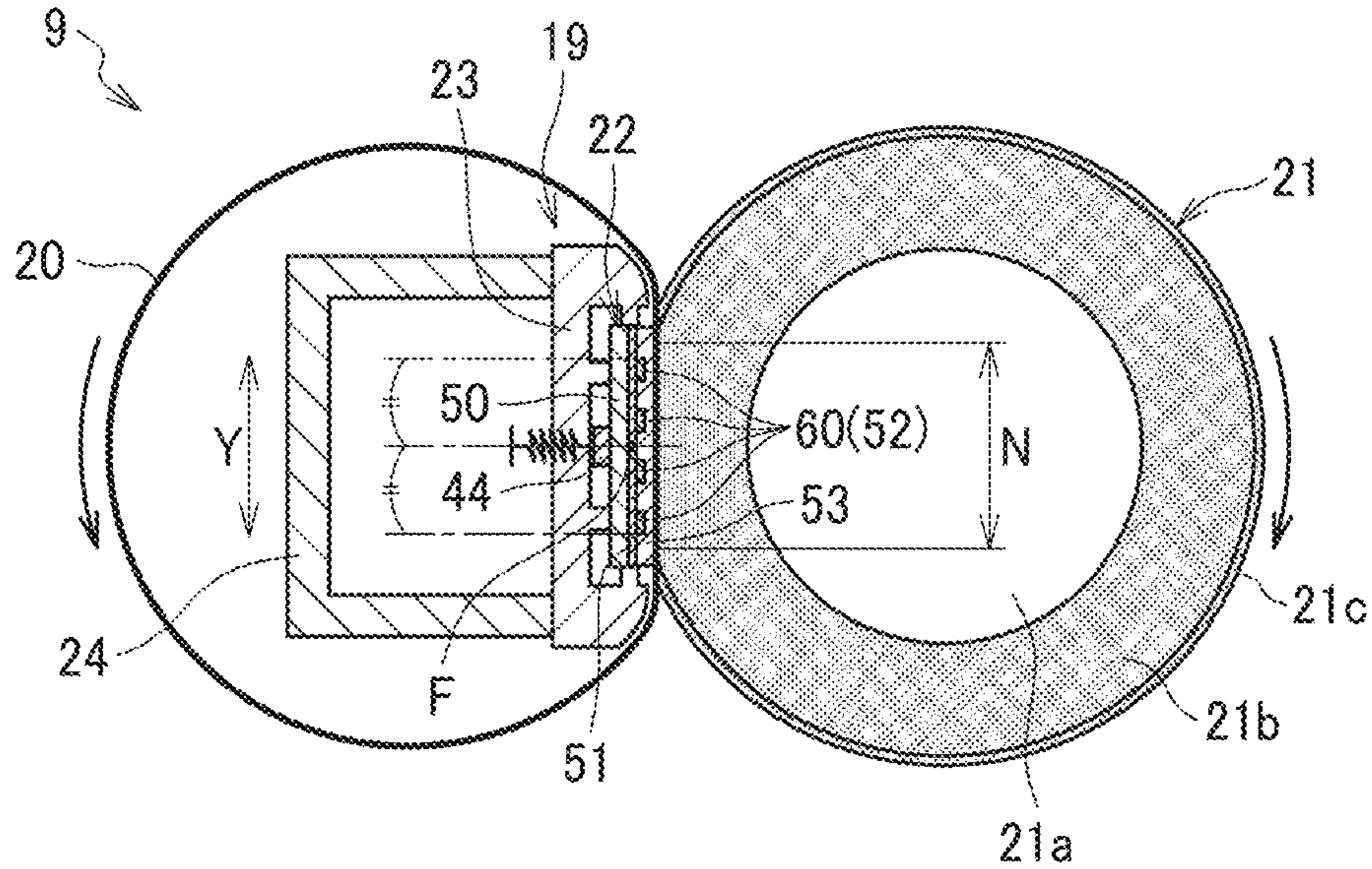
62A
50W
Wb
61B
Y
59
59
59
59
62B
U
60
22W

FIG. 21


9
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60(52)
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44
53
21c
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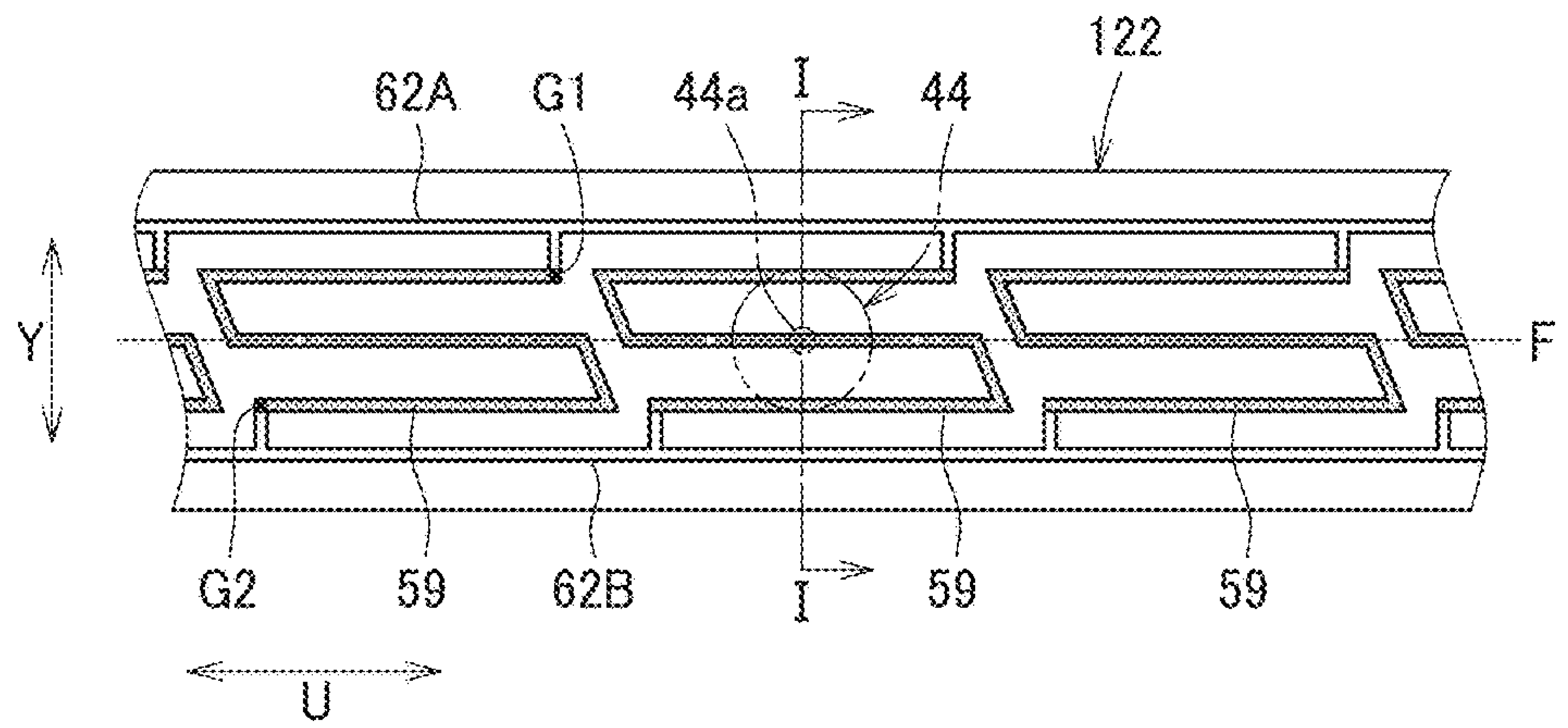
F
51
21b
21a

FIG. 22



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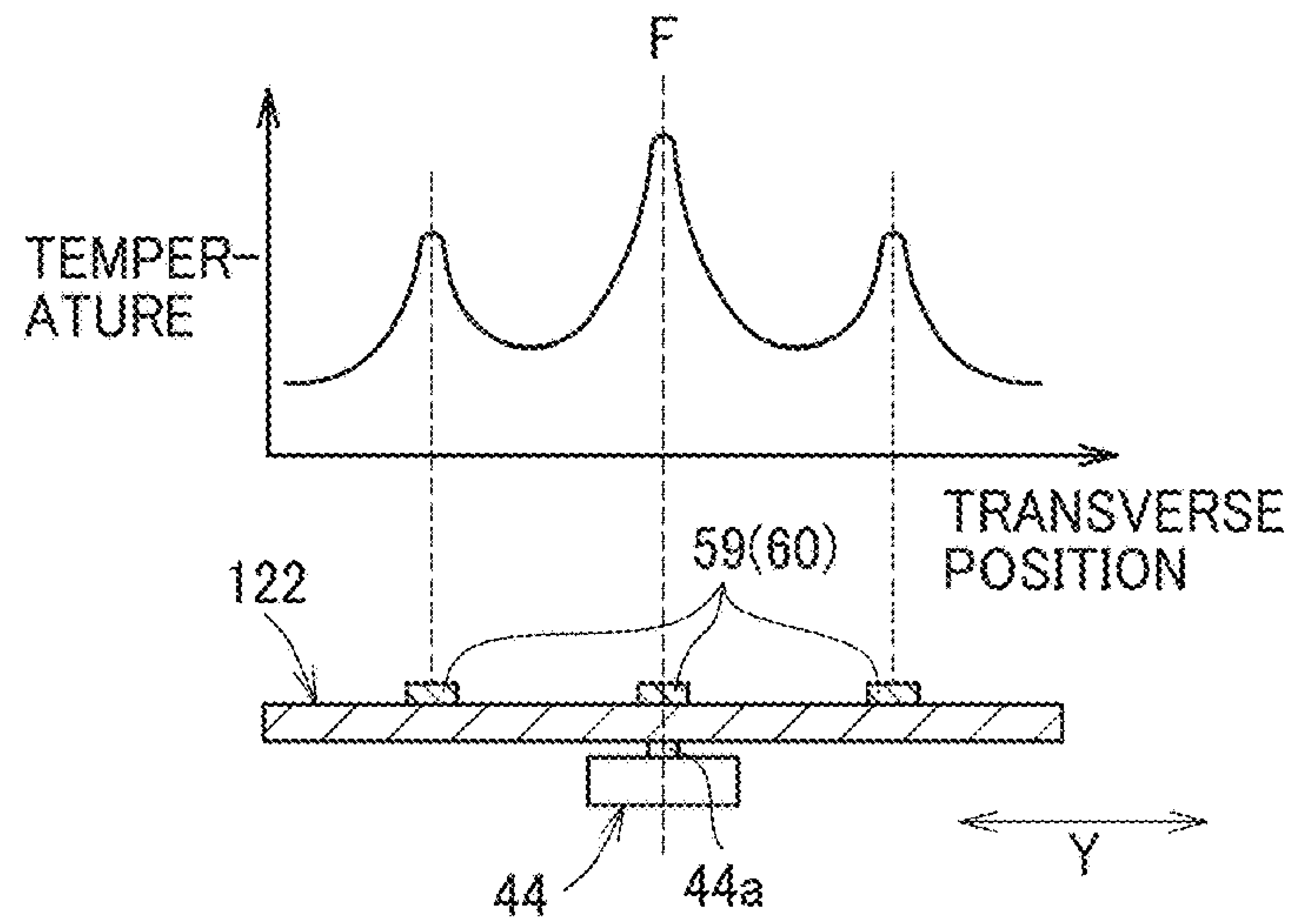


FIG. 24

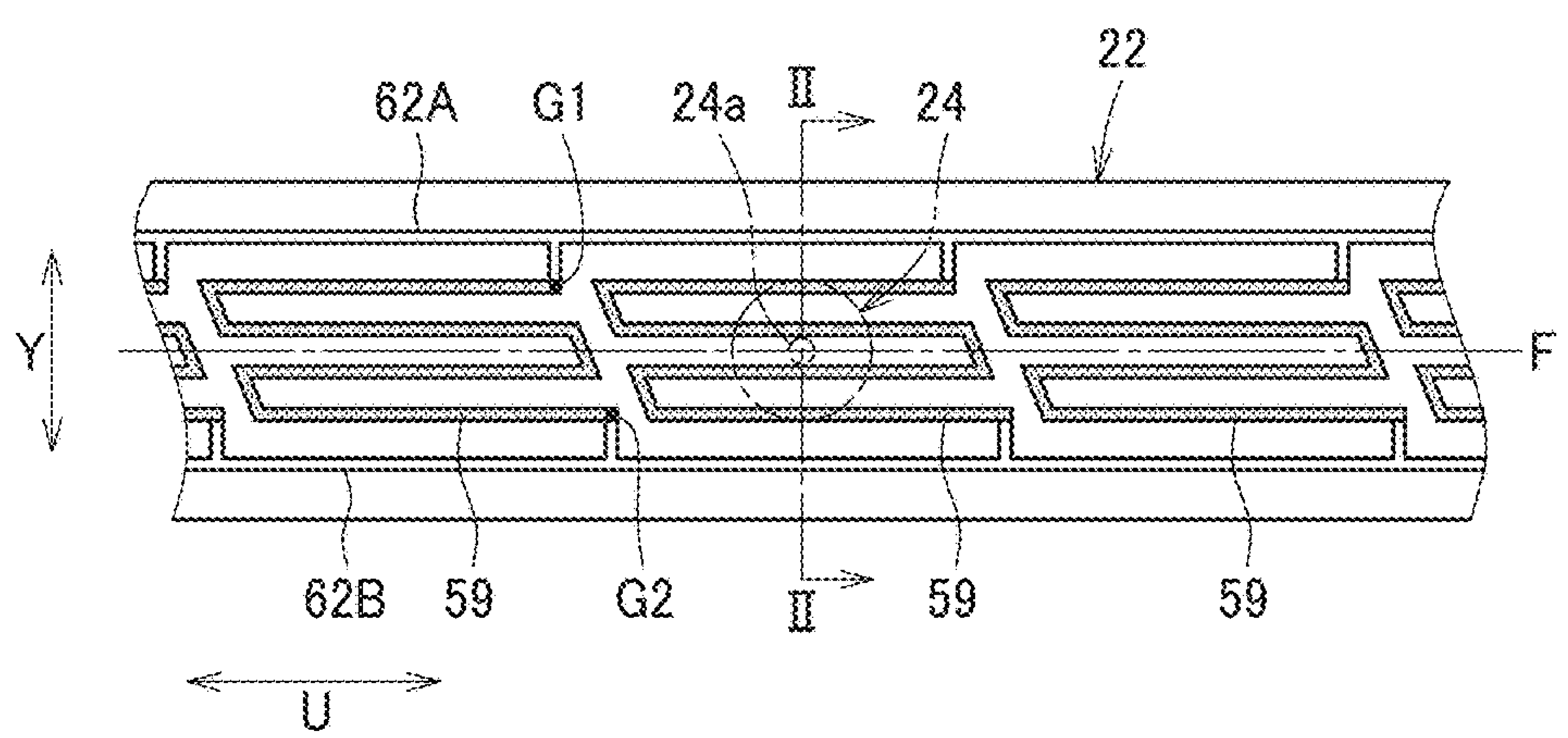


FIG. 25

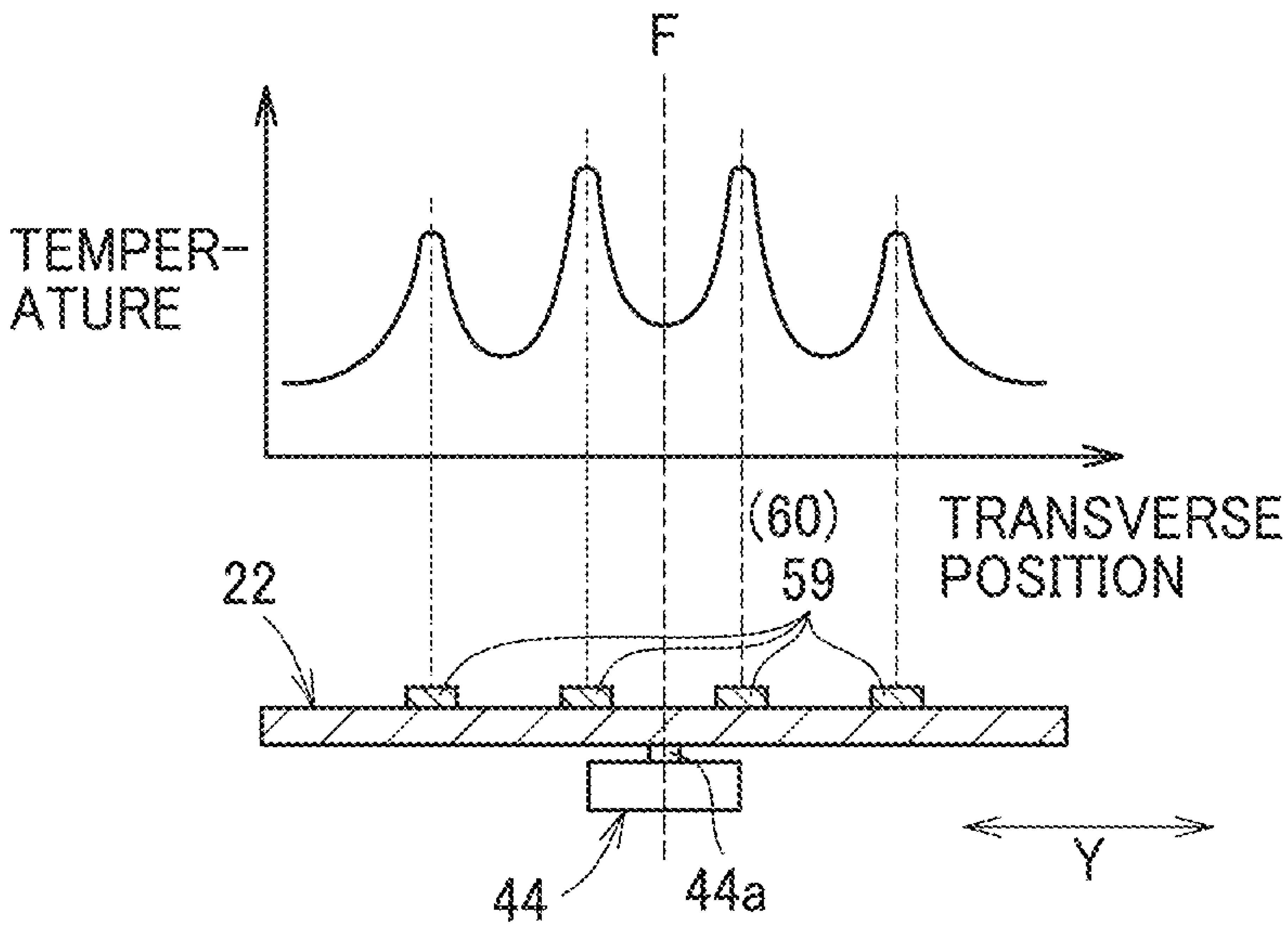

F
TEMPER-
ATURE
TRANSVERSE
POSITION
(60)
59
22
44
44a
Y

FIG. 26

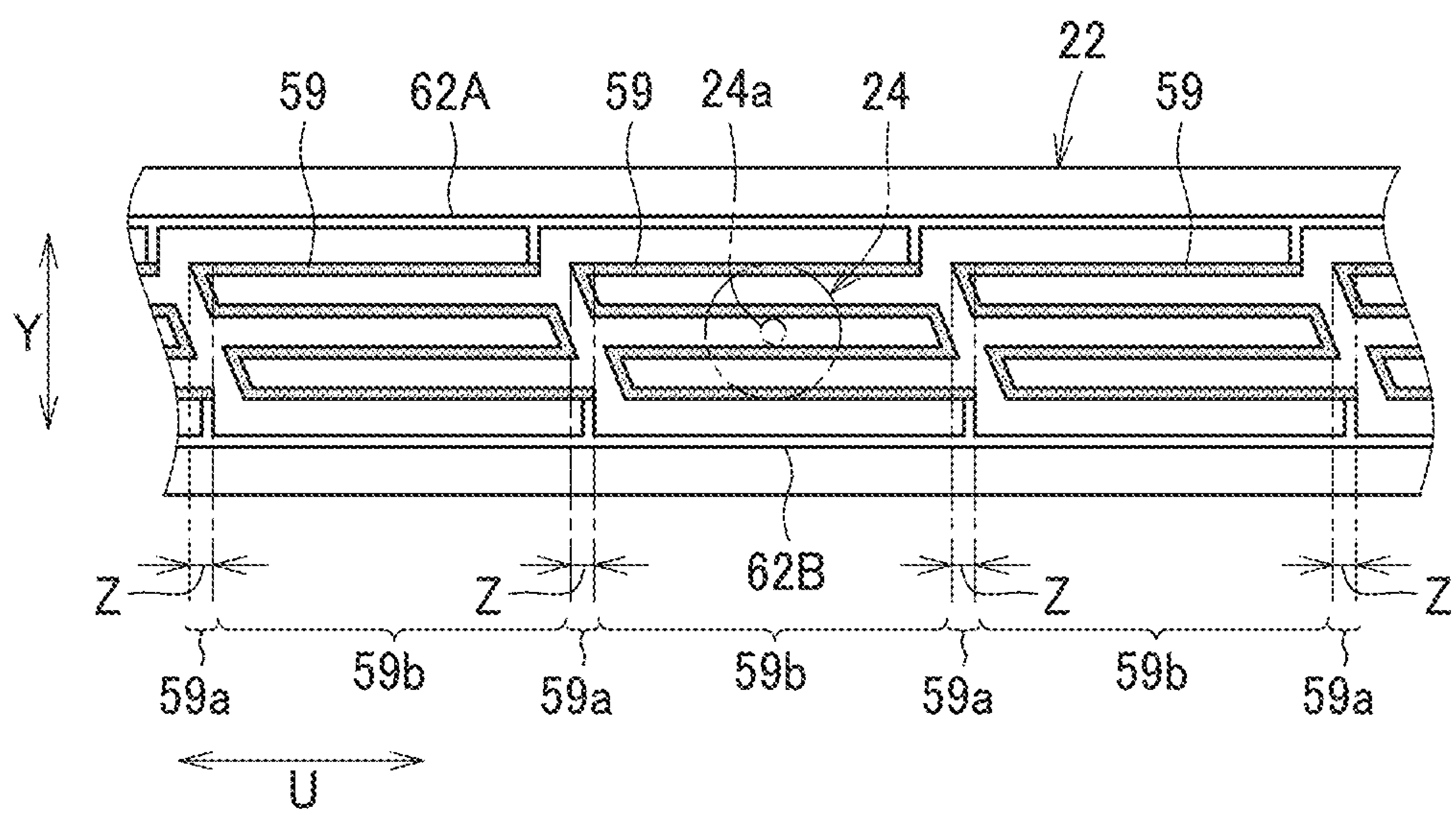

22
59
62A
59
24a
24
59
Y
Z
Z
62B
Z
Z
59a
59b
59a
59b
59a
59b
59a
U

FIG. 27

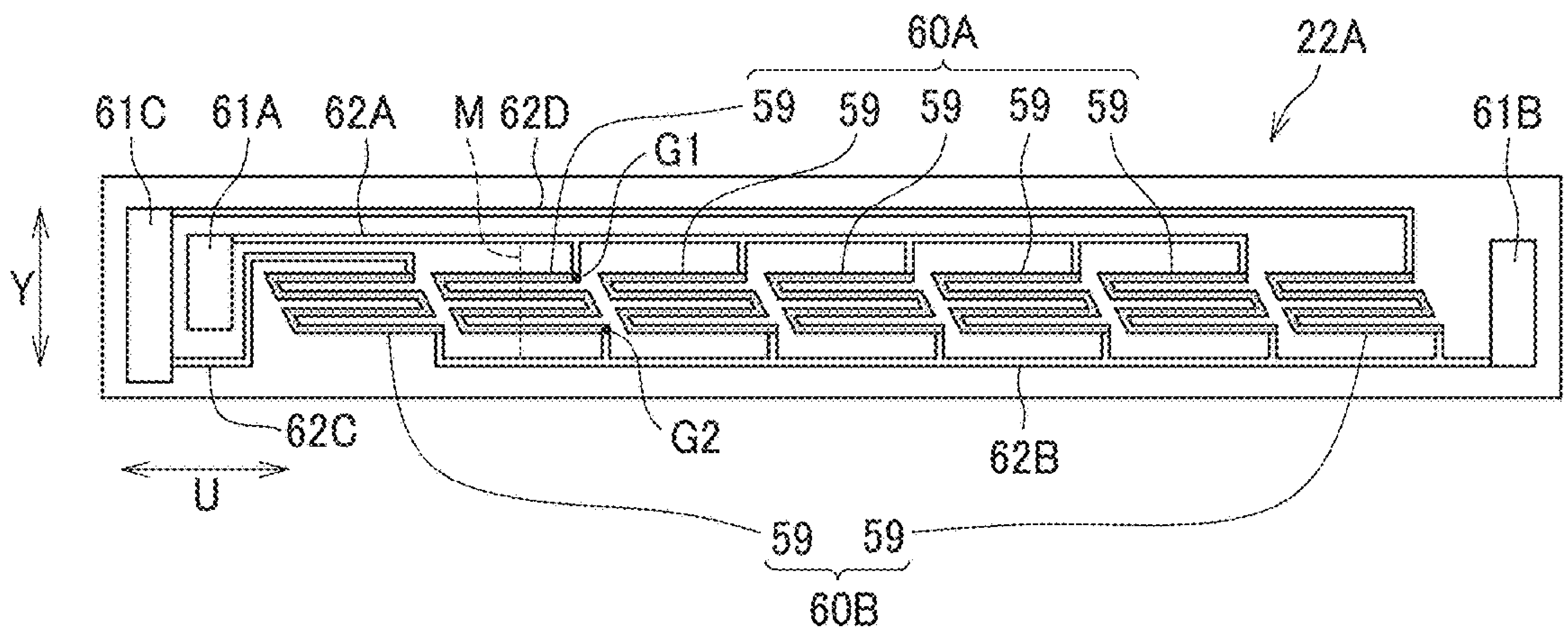


FIG. 28

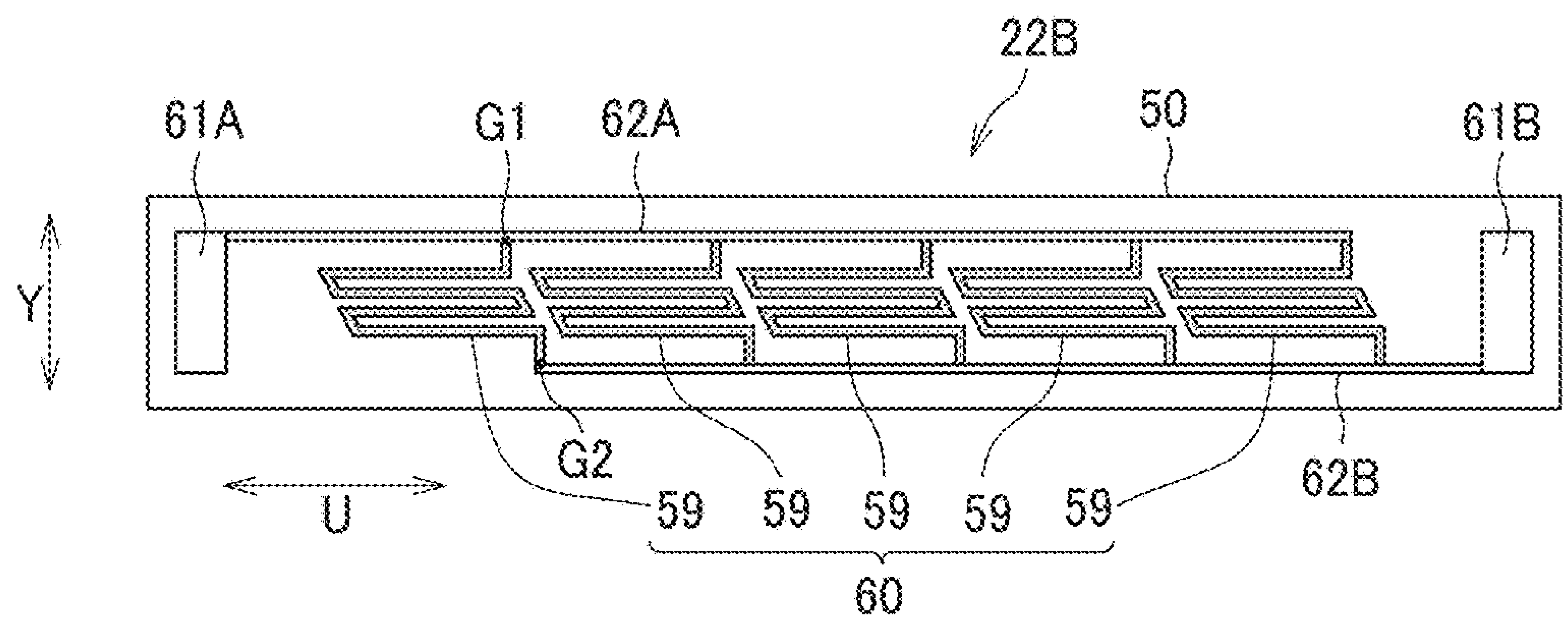


FIG. 29

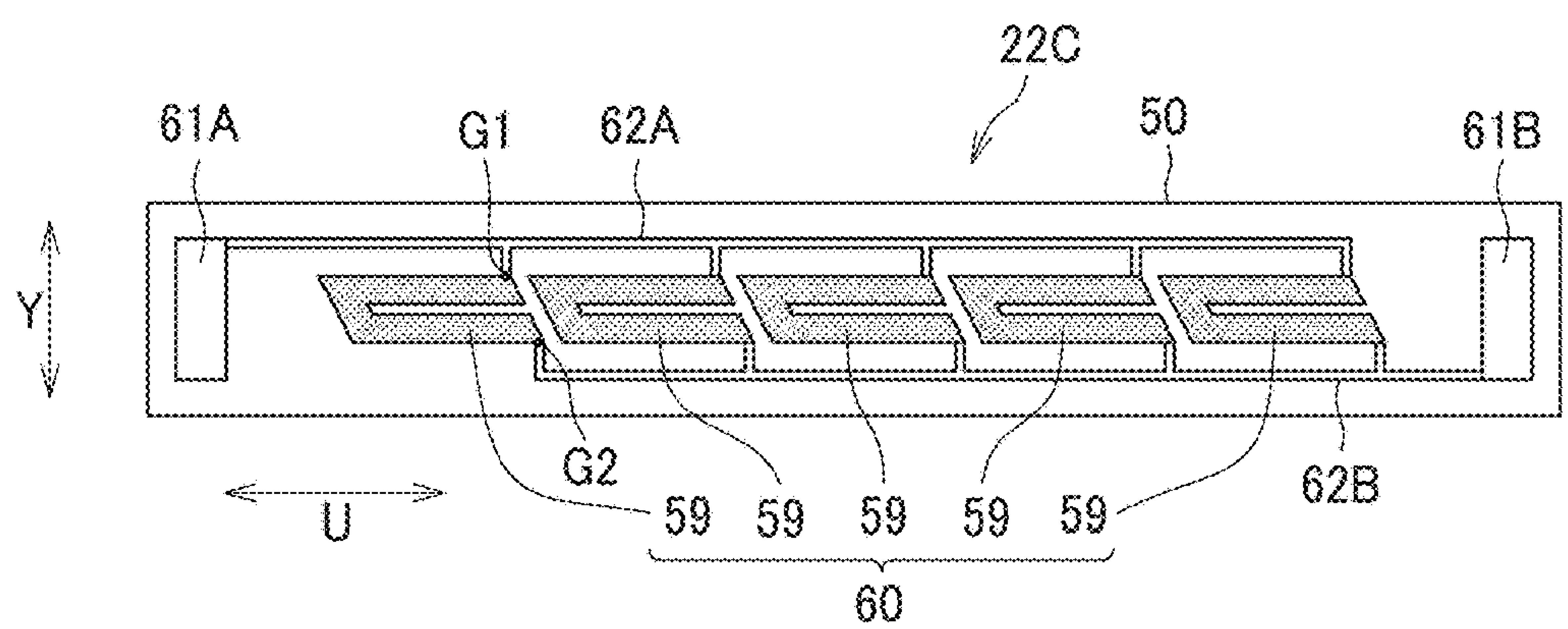
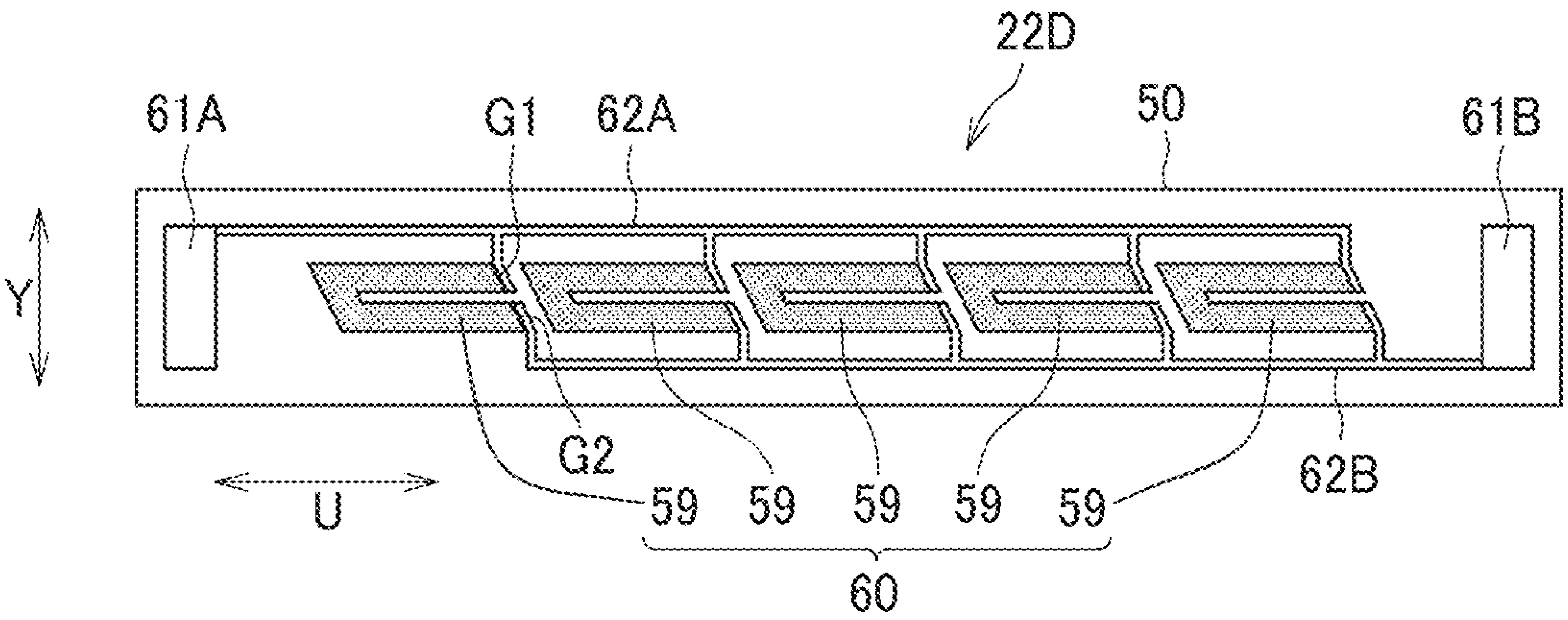


FIG. 30


22D
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G1
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50
61B
Y
G2
U
59
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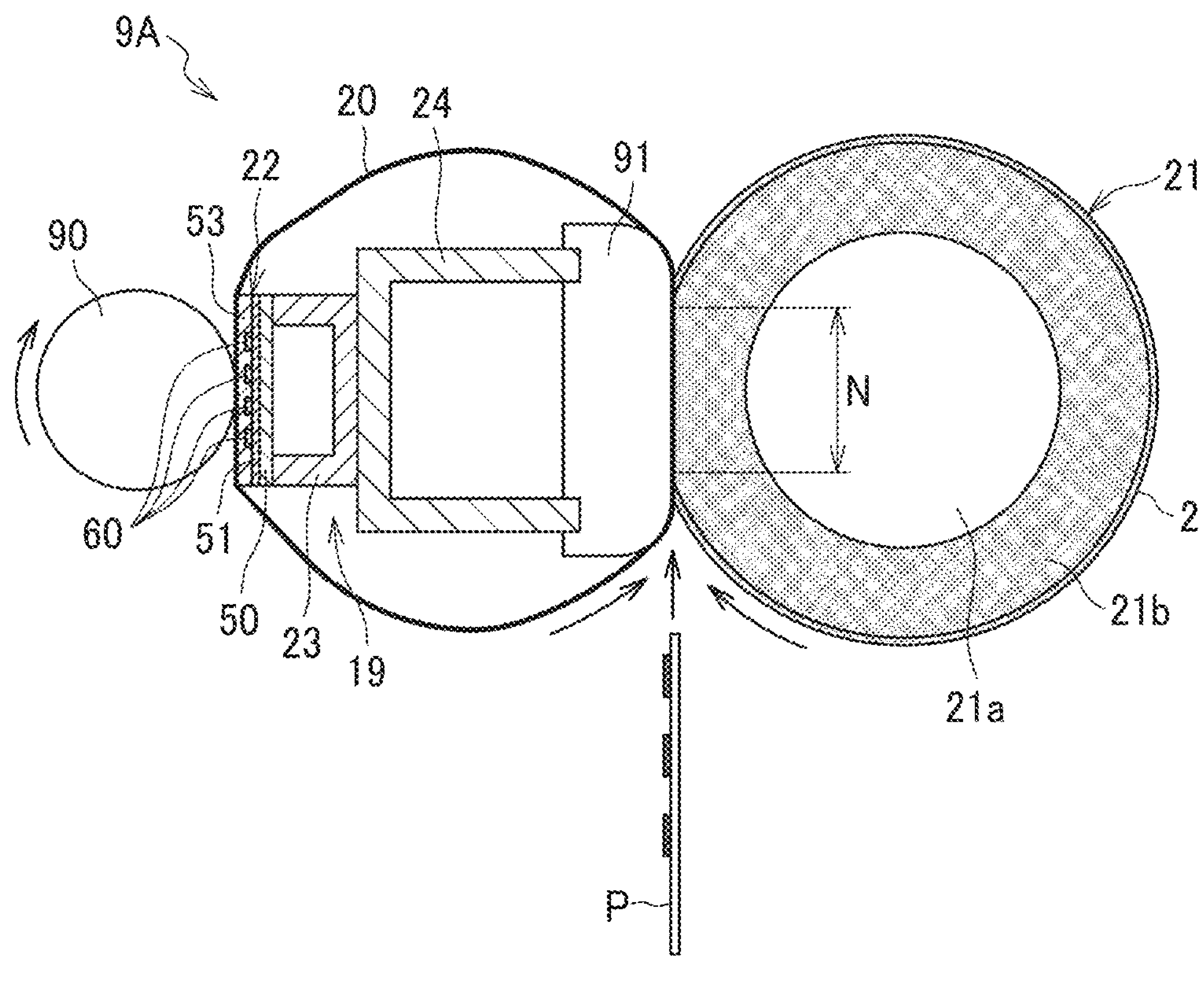
59
62B
60

FIG. 31


9A
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N
21c
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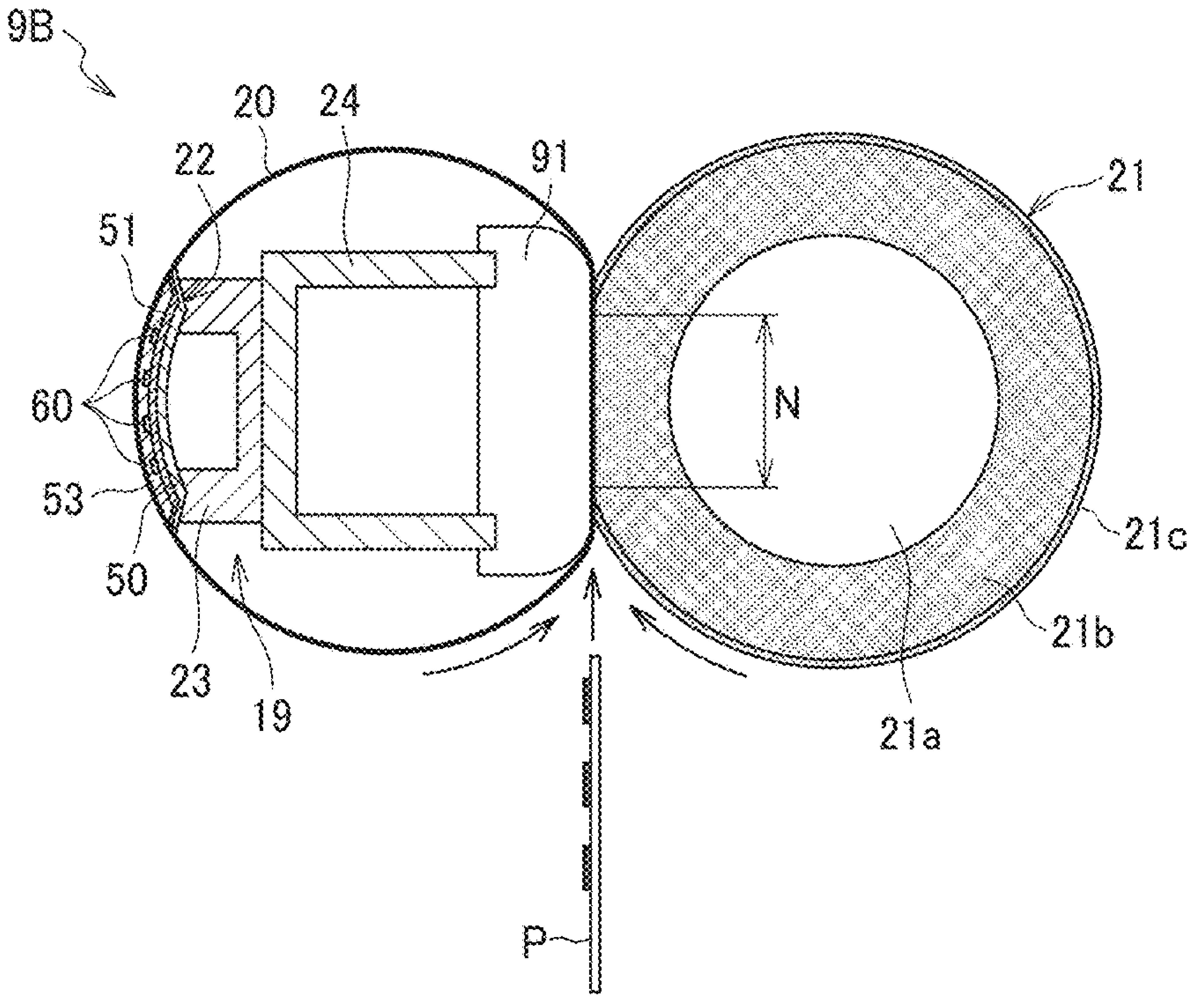
23
19
21b
21a
P

FIG. 32



9B
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91
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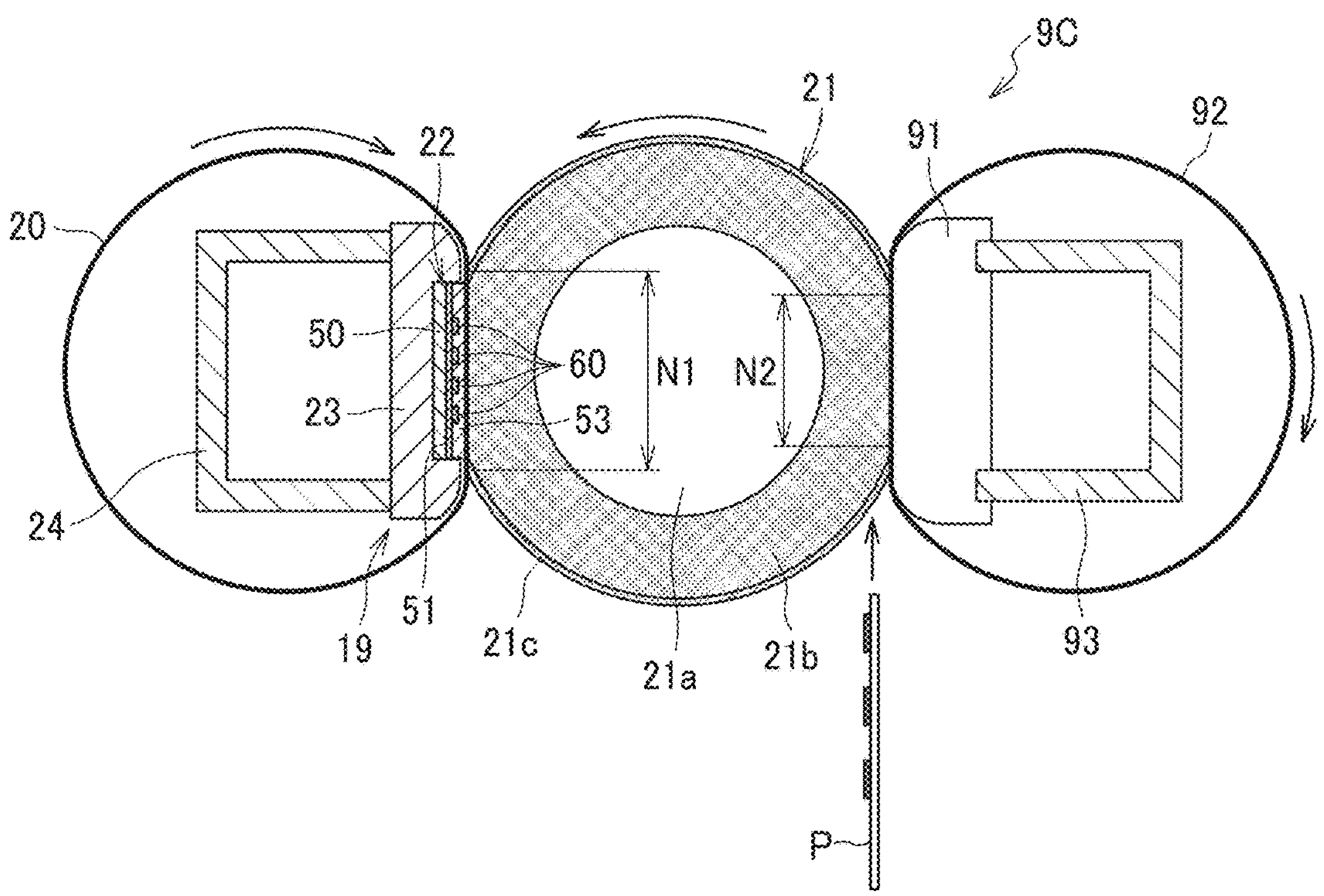
21c
23
19
21b
21a
P

FIG. 33



9C
21
92
22
91
20
50
60
N1
N2
23
53
24
19
51
21c
21a
21b
93
P

IMAGE FORMING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This patent application is is a Continuation of U.S. application Ser. No. 16/942,072, filed on Jul. 29, 2020, which claims priority pursuant to 35 U.S.C. § 119(a) to Japanese Patent Application Nos. 2019-146406, filed on Aug. 8, 2019, 2019-149354, filed on Aug. 16, 2019, 2020-034912, filed on Mar. 2, 2020, and 2020-063726, filed on Mar. 31, 2020, in the Japan Patent Office, the entire disclosure of each of which is hereby incorporated by reference herein.

BACKGROUND

Technical Field

Embodiments of the present disclosure relate to an image forming apparatus.

Related Art

Various types of image forming apparatuses are known, including copiers, printers, facsimile machines, and multifunction machines having two or more of copying, printing, scanning, facsimile, plotter, and other capabilities. Such image forming apparatuses usually form an image on a recording medium according to image data. Specifically, in such image forming apparatuses, for example, a charger uniformly charges a surface of a photoconductor as an image bearer. An optical writer irradiates the surface of the photoconductor thus charged with a light beam to form an electrostatic latent image on the surface of the photoconductor according to the image data. A developing device supplies toner to the electrostatic latent image thus formed to render the electrostatic latent image visible as a toner image. The toner image is then transferred onto a recording medium either directly or indirectly via an intermediate transfer belt. Finally, a fixing device applies heat and pressure to the recording medium bearing the toner image to fix the toner image onto the recording medium. Thus, an image is formed on the recording medium.

The image forming apparatuses often include a heating device. One example of the heating device is the fixing device that fixes toner onto a recording medium under heat. Another example of the heating device is a drying device that dries ink on a recording medium.

SUMMARY

In one embodiment of the present disclosure, a novel image forming apparatus includes a cooler and a heater. The heater includes a heat generation unit, a first electrode, a second electrode, a first conductor, and a second conductor. The heat generation unit includes resistive heat generators arranged in a longitudinal direction of the heater. The first conductor is configured to connect the resistive heat generators in parallel with each other to the first electrode. The second conductor is configured to connect the resistive heat generators in parallel with each other to the second electrode. The first conductor and the second conductor are connected to at least a resistive heat generator of the resistive heat generators on a first longitudinal end side of the heater from a center of the resistive heat generator in the longitudinal direction of the heater. A cooling ability of the cooler to a second longitudinal end side of the heater opposite the first longitudinal end side of the heater is greater than the cooling ability to the first longitudinal end side of the heater.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the embodiments and many of the attendant advantages and features thereof can be readily obtained and understood from the following detailed description with reference to the accompanying drawings, wherein:

FIG. **1** is a schematic cross-sectional view of an image forming apparatus according to an embodiment of the present disclosure;

FIG. **2** is a schematic cross-sectional view of a fixing device incorporated in the image forming apparatus;

FIG. **3** is a perspective view of the fixing device;

FIG. **4** is an exploded perspective view of the fixing device;

FIG. **5** is a perspective view of a heating device incorporated in the fixing device;

FIG. **6** is an exploded perspective view of the heating device;

FIG. **7** is a plan view of a heater incorporated in the heating device;

FIG. **8** is an exploded perspective view of the heater;

FIG. **9** is a perspective view of the heater and a connector coupled to the heater;

FIG. **10**A is a plan view of a comparative heater, illustrating feed lines connected to each resistive heat generator on opposite sides of each resistive heat generator in a longitudinal direction of the comparative heater, with a table indicating the amounts of heat generated by the feed lines for each block;

FIG. **10**B is a graph illustrating the total amount of heat generated by the feed lines for each block;

FIG. **11**A is a plan view of the heater of FIG. **7**, illustrating feed lines connected to each resistive heat generator on one side of each resistive heat generator in a longitudinal direction of the heater, with a table indicating the amounts of heat generated by the feed lines for each block;

FIG. **11**B is a graph illustrating the total amount of heat generated by the feed lines for each block;

FIG. **12** is a cross-sectional plan view of the image forming apparatus;

FIG. **13**A is a plan view of a variation of the heater of FIG. **11**A, illustrating the feed lines connected to each resistive heat generator on another side of each resistive heat generator in a longitudinal direction of the variation of the heater, with a table indicating the amounts of heat generated by the feed lines for each block;

FIG. **13**B is a graph illustrating the total amount of heat generated by the feed lines for each block;

FIG. **14** is a cross-sectional side view of the fixing device, illustrating a first example of location of a temperature sensor;

FIG. **15** is another cross-sectional side view of the fixing device, illustrating a second example of location of the temperature sensor;

FIG. **16** is a cross-sectional plan view of the image forming apparatus, illustrating a first example of location of the temperature sensor in the longitudinal direction of the heater;

FIG. **17** is another cross-sectional plan view of the image forming apparatus, illustrating a second example of location of the temperature sensor in the longitudinal direction of the heater;

FIG. **18** is a cross-sectional plan view of an image forming apparatus according to another embodiment of the present disclosure;

FIG. **19** is a plan view of the heater, illustrating a transverse dimension of the heater and a transverse dimension of the resistive heat generators;

FIG. **20** is a plan view of a variation of the heater illustrated in FIG. **19**, illustrating a longitudinal dimension of the variation of the heater, a transverse dimension of the variation of the heater, and a transverse dimension of the feed lines;

FIG. **21** is a schematic cross-sectional view of the fixing device, illustrating a heater temperature sensor provided for the heater;

FIG. **22** is a schematic view of the comparative heater of FIG. **10**A, illustrating the feed lines connected to each resistive heat generator on the opposite sides of each resistive heat generator in the longitudinal direction of the comparative heater, with a location of the heater temperature sensor in the transverse direction of the comparative heater;

FIG. **23** is a graph of a temperature distribution of the comparative heater in an I-I cross section of FIG. **22**, with a cross-sectional view of the comparative heater along a line I;

FIG. **24** is a schematic view of the heater of FIG. **7**, illustrating the feed lines connected to each resistive heat generator on one side in the longitudinal direction of the heater, with a location of the heater temperature sensor in the transverse direction of the heater;

FIG. **25** is a graph of a temperature distribution of the heater in a II-II cross section of FIG. **24**, with a cross-sectional view of the heater along a line II;

FIG. **26** is a schematic view of the heater, illustrating a location of the heater temperature sensor in the longitudinal direction of the heater;

FIG. **27** is a plan view of a first variation of the heater illustrated in FIG. **7**;

FIG. **28** is a plan view of a second variation of the heater illustrated in FIG. **7**;

FIG. **29** is a plan view of a third variation of the heater illustrated in FIG. **7**;

FIG. **30** is a plan view of a fourth variation of the heater illustrated in FIG. **7**;

FIG. **31** is a cross-sectional view of a first variation of the fixing device illustrated in FIG. **2**;

FIG. **32** is a cross-sectional view of a second variation of the fixing device illustrated in FIG. **2**; and

FIG. **33** is a cross-sectional view of a third variation of the fixing device illustrated in FIG. **2**.

The accompanying drawings are intended to depict embodiments of the present disclosure and should not be interpreted to limit the scope thereof. Also, identical or similar reference numerals designate identical or similar components throughout the several views.

DETAILED DESCRIPTION

In describing embodiments illustrated in the drawings, specific terminology is employed for the sake of clarity. However, the disclosure of the present specification is not intended to be limited to the specific terminology so selected and it is to be understood that each specific element includes all technical equivalents that have a similar function, operate in a similar manner, and achieve a similar result.

Although the embodiments are described with technical limitations with reference to the attached drawings, such description is not intended to limit the scope of the disclosure and not all of the components or elements described in the embodiments of the present disclosure are indispensable to the present disclosure.

In a later-described comparative example, embodiment, and exemplary variation, for the sake of simplicity, like reference numerals are given to identical or corresponding constituent elements such as parts and materials having the same functions, and redundant descriptions thereof are omitted unless otherwise required.

As used herein, the singular forms "a," "an," and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise.

It is to be noted that, in the following description, suffixes Y, M, C, and Bk denote colors of yellow, magenta, cyan, and black, respectively. To simplify the description, these suffixes are omitted unless necessary.

Referring to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views, embodiments of the present disclosure are described below.

Initially with reference to FIG. **1**, a description is given of an image forming apparatus **100** according to an embodiment of the present disclosure.

FIG. **1** is a schematic cross-sectional view of the image forming apparatus **100**.

As illustrated in FIG. **1**, the image forming apparatus **100** includes four image forming units **1**Y, **1**M, **1**C, and **1**Bk serving as image forming devices, respectively. The image forming units **1**Y, **1**M, **1**C, and **1**Bk are removably installed in a body **103** of the image forming apparatus **100**. The image forming units **1**Y, **1**M, **1**C, and **1**Bk have identical configurations, except that the image forming units **1**Y, **1**M, **1**C, and **1**Bk contain developers in different colors, namely, yellow (Y), magenta (M), cyan (C), and black (Bk), respectively. The yellow, magenta, cyan, and black correspond to color-separation components of a color image. Specifically, each of the image forming units **1**Y, **1**M, **1**C, and **1**Bk includes a drum-shaped photoconductor **2**, a charger **3**, a developing device **4**, and a cleaner **5**. The photoconductor **2** serves as an image bearer that bears an electrostatic latent image and a resultant toner image. The charger **3** charges a circumferential surface of the photoconductor **2**. The developing device **4** supplies toner as a developer to the electrostatic latent image formed on the circumferential surface of the photoconductor **2**, rendering the electrostatic latent image visible as a toner image. In short, the developing device **4** forms a toner image on the photoconductor **2**. The cleaner **5** cleans the circumferential surface of the photoconductor **2**.

The image forming apparatus **100** further includes an exposure device **6**, a sheet feeding device **7**, a transfer device **8**, a fixing device **9**, and a sheet ejection device **10**. The exposure device **6** exposes the circumferential surface of the photoconductor **2** to form an electrostatic latent image. The sheet feeding device **7** feeds or supplies a sheet P serving as a recording medium. The transfer device **8** transfers the toner image from the photoconductor **2** onto the sheet P. The fixing device **9** fixes the toner image onto the sheet P. The sheet ejection device **10** ejects the sheet P outside the image forming apparatus **100**.

The transfer device **8** includes an intermediate transfer belt **11**, four primary transfer rollers **12**, and a secondary transfer roller **13**. The intermediate transfer belt **11** is an endless belt serving as an intermediate transferor entrained around a plurality of rollers. Each of the four primary transfer rollers **12** serves as a primary transferor that transfers the toner image from the corresponding photoconductor

2 onto the intermediate transfer belt **11**. The secondary transfer roller **13** serves as a secondary transferor that transfers the toner images from the intermediate transfer belt **11** onto the sheet P. The four primary transfer rollers **12** contact the respective photoconductors **2** via the intermediate transfer belt **11**. In other words, each of the photoconductors **2** contacts the intermediate transfer belt **11**, thereby forming an area of contact, herein referred to as a primary transfer nip, between each of the photoconductors **2** and the intermediate transfer belt **11**. On the other hand, the secondary transfer roller **13** contacts, via the intermediate transfer belt **11**, one of the plurality of rollers around which the intermediate transfer belt **11** is entrained. Thus, the secondary transfer roller **13** forms an area of contact, herein referred to as a secondary transfer nip, between the secondary transfer roller **13** and the intermediate transfer belt **11**.

Inside the image forming apparatus **100**, the sheet P is conveyed from the sheet feeding device **7** along a sheet conveyance passage **14** that is defined by internal components of the image forming apparatus **100**. A timing roller pair **15** is disposed between the sheet feeding device **7** and the secondary transfer nip (defined by the secondary transfer roller **13**) on the sheet conveyance passage **14**.

To provide a fuller understanding of the embodiments of the present disclosure, a description is now given of a series of image forming operations of the image forming apparatus **100** with continued reference to FIG. **1**.

When the image forming apparatus **100** receives an instruction to start a print job (i.e., a series of image forming operations), a driver drives and rotates the photoconductor **2** clockwise in FIG. **1** in each of the image forming units **1**Y, **1**M, **1**C, and **1**Bk. The charger **3** charges the circumferential surface of the photoconductor **2** uniformly at a high electric potential. According to image information of a document read by a document reading device or print information instructed to print from a terminal, the exposure device **6** exposes the circumferential surface of each of the photoconductors **2** to decrease the electrostatic potential at an exposed portion, thereby forming an electrostatic latent image on the circumferential surface of each of the photoconductors **2**. The developing device **4** supplies toner to the electrostatic latent image, rendering the electrostatic latent image visible as a toner image. Thus, the developing device **4** forms a toner image on the photoconductor **2**.

The toner image thus formed on the photoconductor **2** reaches the primary transfer nip (defined by the primary transfer roller **12**) as the photoconductor **2** rotates. At the primary transfer nip, the toner image is transferred onto the intermediate transfer belt **11** that is rotated counterclockwise in FIG. **1**. Specifically, the toner images are sequentially transferred from the respective photoconductors **2** onto the intermediate transfer belt **11** such that the toner images are superimposed one atop another, as a composite full-color toner image on the intermediate transfer belt **11**. The full-color toner image on the intermediate transfer belt **11** is conveyed to the secondary transfer nip (defined by the secondary transfer roller **13**) as the intermediate transfer belt **11** rotates. At the secondary transfer nip, the full-color toner image is transferred onto the sheet P supplied and conveyed from the sheet feeding device **7**. Specifically, the sheet P supplied from the sheet feeding device **7** is temporarily stopped by the timing roller pair **15**. Rotation of the timing roller pair **15** is timed to send out the sheet P to the secondary transfer nip such that the sheet P meets the full-color toner image on the intermediate transfer belt **11** at the secondary transfer nip. Thus, the full-color toner image is transferred onto the sheet P. In other words, the sheet P bears the full-color toner image. Note that after the toner image is transferred from the photoconductor **2** onto the intermediate transfer belt **11**, the cleaner **5** removes residual toner from the photoconductor **2**. The residual toner herein refers to toner that has failed to be transferred onto the intermediate transfer belt **11** and therefore remains on the surface of the photoconductor **2**.

The sheet P bearing the full-color toner image is conveyed to the fixing device **9**, which fixes the full-color toner image onto the sheet P. Thereafter, the sheet ejection device **10** ejects the sheet P outside the image forming apparatus **100**. Thus, a series of image forming operations is completed.

Referring now to FIG. **2**, a description is given of a configuration of the fixing device **9** incorporated in the image forming apparatus **100** described above.

FIG. **2** is a schematic cross-sectional view of the fixing device **9**.

As illustrated in FIG. **2**, the fixing device **9** according to the present embodiment includes a heating device **19**, a fixing belt **20**, and a pressure roller **21**. The fixing belt **20** and the heating device **19** disposed inside a loop formed by the fixing belt **20** constitute a belt unit **20**U that is detachably coupled to the pressure roller **21**. Specifically, the heating device **19** heats the fixing belt **20**. The fixing belt **20** is an endless belt serving as a fixing rotator. The pressure roller **21** contacts an outer circumferential surface of the fixing belt **20** to form an area of contact, herein referred to as a fixing nip N, between the fixing belt **20** and the pressure roller **21**. Since the pressure roller **21** is disposed opposite the fixing belt **20**, the pressure roller **21** serves as an opposed rotator. The heating device **19** includes, e.g., a planar heater **22**, a heater holder **23**, and a stay **24**. The heater holder **23** holds the heater **22**. The stay **24** serves as a reinforcement that reinforces the heater holder **23** along a longitudinal direction of the heater holder **23**.

The endless fixing belt **20** is constructed of a cylindrical base layer and a release layer. The base layer, made of polyimide (PI), has an outer diameter of 25 mm and a thickness in a range of from 40 μm to 120 μm, for example. The release layer, serving as an outermost layer of the fixing belt **20**, has a thickness in a range of from 5 μm to 50 μm and is made of fluororesin such as tetrafluoroethylene-perfluoroalkylvinylether copolymer or perfluoroalkylvinyl ether polymer (PFA) or polytetrafluoroethylene (PTFE), to enhance durability of the fixing belt **20** and facilitate separation of toner, which is contained in a toner image on the sheet P, from the fixing belt **20**. Optionally, an elastic layer made of, e.g., rubber having a thickness in a range of from 50 μm to 500 μm may be interposed between the base layer and the release layer. The base layer of the fixing belt **20** is not limited to polyimide. Alternatively, the base layer of the fixing belt **20** may be made of heat resistant resin such as polyether ether ketone (PEEK), or metal such as nickel (Ni) or steel use stainless (SUS). An inner circumferential surface of the fixing belt **20** may be coated with, e.g., PI or PTFE to produce a slide layer.

The pressure roller **21** has an outer diameter of 25 mm, for example. The pressure roller **21** is constructed of a core **21***a*, an elastic layer **21***b*, and a release layer **21***c*. The core **21***a* is a solid core made of iron. The elastic layer **21***b* rests on a circumferential surface of the core **21***a*. The release layer **21***c* rests on an outer circumferential surface of the elastic layer **21***b*. The elastic layer **21***b* is made of silicone rubber and has a thickness of 3.5 mm, for example. The release layer **21***c* resting on the outer circumferential surface of the elastic layer **21***b* is preferably a fluoroplastic layer having a thickness of about 40 μm, for example, to facilitate separation of the sheet P and a foreign substance from the pressure roller **21**.

A spring serving as a biasing member described later causes the fixing belt **20** and the pressure roller **21** to press against each other. Thus, the fixing nip N is formed between the fixing belt **20** and the pressure roller **21**. As a driving force is transmitted to the pressure roller **21** from a driver disposed in the body **103** of the image forming apparatus **100**, the pressure roller **21** rotates and serves as a driving roller that drives and rotates the fixing belt **20**. The fixing belt **20** is thus driven and rotated by the pressure roller **21** as the pressure roller **21** rotates. When the fixing belt **20** rotates, the fixing belt **20** slides on the heater **22**. Therefore, in order to facilitate sliding of the fixing belt **20**, a lubricant such as oil or grease may be provided between the heater **22** and the fixing belt **20**.

The heater **22** is longitudinally disposed along an axial or longitudinal direction of the fixing belt **20**. In other words, a longitudinal direction of the heater **22** is parallel to the longitudinal direction (i.e., axial direction) of the fixing belt **20**. The heater **22** contacts the inner circumferential surface of the fixing belt **20** at a position opposite the pressure roller **21**. The heater **22** is a substantially rectangular flat plate having a long side along the longitudinal direction of the fixing belt **20**. The heater **22** includes, e.g., a plate-like base **50**, a first insulation layer **51** resting on the base **50**, a conductor layer **52** including a heat generation unit **60** and resting on the first insulation layer **51**, and a second insulation layer **53** that covers the conductor layer **52**. In the present embodiment, the base **50**, the first insulation layer **51**, the conductor layer **52** (including the heat generation unit **60**), and the second insulation layer **53** are layered in this order toward the fixing belt **20**, in other words, toward the fixing nip N. Heat generated from the heat generation unit **60** is conducted to the fixing belt **20** via the second insulation layer **53**.

Unlike the present embodiment, the heat generation unit **60** may be provided on a heater-holder side of the base **50**. The heater-holder side of the base **50** is a surface facing the heater holder **23** away from the fixing belt **20**. In such a case, since the heat is conducted from the heat generation unit **60** to the fixing belt **20** via the base **50**, the base **50** is preferably made of a material having an increased thermal conductivity such as aluminum nitride. The heater **22** according to the present embodiment may further include an insulation layer on the heater-holder side of the base **50**.

The heater **22** may not contact the fixing belt **20** or may contact the fixing belt **20** indirectly via, e.g., a low friction sheet. In the present embodiment, the heater **22** directly contacts the fixing belt **20** to efficiently conduct heat to the fixing belt **20**. The heater **22** may contact the outer circumferential surface of the fixing belt **20**. By contrast, in a case in which the heater **22** contacts the inner circumferential surface of the fixing belt **20**, the outer circumferential surface of the fixing belt **20** does not contact the heater **22** and therefore remains protected. Accordingly, the toner image is reliably fixed on the sheet P.

The heater holder **23** and the stay **24** are disposed opposite the inner circumferential surface of the fixing belt **20**. In other words, the heater holder **23** and the stay **24** are disposed inside the loop formed by the fixing belt **20**. The stay **24** includes a channel made of metal. Opposed longitudinal end portions of the stay **24** are supported by opposed side walls of the fixing device **9**, respectively. The stay **24** contacts a stay side of the heater holder **23**. The stay side of the heater holder **23** is a surface facing the stay **24** away from the heater **22**. Accordingly, the stay **24** supports the heater holder **23** while retaining the heater **22** and the heater holder **23** to be immune from being bent substantially by pressure from the pressure roller **21**. Thus, the fixing nip N is formed between the fixing belt **20** and the pressure roller **21**.

The heater holder **23** is susceptible to a temperature increase or overheating as the heater holder **23** receives heat from the heater **22**. Therefore, the heater holder **23** is preferably made of a heat-resistant material. For example, the heater holder **23** may be made of a heat-resistant resin having a decreased thermal conductivity such as liquid crystal polymer (LCP) or PEEK. In such a case, the heater holder **23** reduces conduction of heat from the heater **22** to the heater holder **23**, allowing the heater **22** to efficiently heat the fixing belt **20**.

As a print job starts, the heater **22** supplied with power causes the heat generation unit **60** to generate heat, thus heating the fixing belt **20**. Meanwhile, the pressure roller **21** is rotated. The rotation of the pressure roller **21** rotates the fixing belt **20**. As illustrated in FIG. **2**, the sheet P bearing an unfixed toner image is conveyed through the fixing nip N between the pressure roller **21** and the fixing belt **20** that reaches a given target temperature (i.e., fixing temperature). At the fixing nip N, the unfixed toner image is fixed onto the sheet P under heat and pressure.

Referring now to FIGS. **3** and **4**, a detailed description is given of the configuration of the fixing device **9**.

FIG. **3** is a perspective view of the fixing device **9**. FIG. **4** is an exploded perspective view of the fixing device **9**.

As illustrated in FIGS. **3** and **4**, the fixing device **9** includes a device frame **40**, which includes a first device frame **25** and a second device frame **26**. The first device frame **25** includes a pair of side walls **28** and a front wall **27**. The second device frame **26** includes a rear wall **29**. The side walls **28** in pair are disposed on one longitudinal end side (i.e., axial end side) and another longitudinal end side of the fixing belt **20**, respectively. The side walls **28** respectively support opposed longitudinal end sides of the heating device **19** and opposed axial end sides of each of the fixing belt **20** and the pressure roller **21**. Each of the side walls **28** is provided with a plurality of engaging projections **28*a***. As the engaging projections **28*a*** engage respective engaging holes **29*a*** penetrating through the rear wall **29**, the first device frame **25** is coupled to the second device frame **26**.

Each of the side walls **28** has an insertion recess **28*b*** through which, e.g., a rotary shaft of the pressure roller **21** is inserted. The insertion recess **28*b*** is open on a rear wall **29** side and closed on the other side. The closed side defines a contact portion. A bearing **30** is disposed at an end of the contact portion to support the rotary shaft of the pressure roller **21**. As opposed axial ends of the rotary shaft of the pressure roller **21** are attached to the respective bearings **30**, the pressure roller **21** is rotatably supported by the pair of side walls **28**.

A driving force transmission gear **31** serving as a driving force transmitter is disposed on an axial end side of the rotary shaft of the pressure roller **21**. In a state in which the pair of side walls **28** supports the pressure roller **21**, the driving force transmission gear **31** is exposed outside the side wall **28**. Accordingly, when the fixing device **9** is installed in the body **103** of the image forming apparatus **100**, the driving force transmission gear **31** is coupled to a gear disposed inside the body **103** to transmit the driving force from the driver. Note that the driving force transmitter that transmits the driving force to the pressure roller **21** may be, e.g., a coupler or pulleys around which a driving force transmission belt is entrained, instead of the driving force transmission gear **31**.

Supports **32** in pair (or a pair of supports **32**) are disposed at opposed longitudinal ends of the heating device **19**, respectively, to support, e.g., the fixing belt **20**, the heater holder **23**, and the stay **24**. Each of the supports **32** includes guide recesses **32***a*. As the guide recesses **32***a* move along edges of the insertion recess **28***b* of the side wall **28**, respectively, the support **32** is attached to the side wall **28**.

A pair of springs **33** serving as a pair of biasing members is interposed between the pair of supports **32** and the rear wall **29**. As the pair of springs **33** biases the stay **24** and the pair of supports **32** toward the pressure roller **21**, the fixing belt **20** is pressed against the pressure roller **21** to form the fixing nip N between the fixing belt **20** and the pressure roller **21**.

As illustrated in FIG. **4**, a hole **29***b* is provided on one longitudinal end side of the rear wall **29** of the second device frame **26**. The hole **29***b* serves as a positioner, specifically, a fixing-device positioner that positions a body of the fixing device **9** relative to the body **103** of the image forming apparatus **100**. On the other hand, the body **103** of the image forming apparatus **100** is provided with a projection **101** serving as a positioner. As the projection **101** is inserted into the hole **29***b* of the fixing device **9**, the projection **101** engages the hole **29***b*, thus positioning the body of the fixing device **9** relative to the body **103** of the image forming apparatus **100** in the longitudinal direction of the fixing belt **20**. Note that no positioner is provided on another longitudinal end side of the rear wall **29** opposite the aforementioned longitudinal end side of the rear wall **29** on which the hole **29***b* is provided. Such a configuration does not restrict thermal expansion or shrinkage of the body of the fixing device **9** in the longitudinal direction of the fixing belt **20** caused by changes in temperature.

Referring now to FIGS. **5** and **6**, a detailed description is given of a configuration of the heating device **19** incorporated in the fixing device **9**.

FIG. **5** is a perspective view of the heating device **19**. FIG. **6** is an exploded perspective view of the heating device **19**.

As illustrated in FIGS. **5** and **6**, the heater holder **23** includes a rectangular accommodating recess **23***a* on a belt-side surface of the heater holder **23** to accommodate the heater **22**. Note that the belt-side surface of the heater holder **23** faces the fixing belt **20** and the fixing nip N. The belt-side surface of the heater holder **23** is a surface on a front side in FIGS. **5** and **6**. The accommodating recess **23***a* has substantially the same shape and size as the shape and size of the heater **22**. Specifically, however, a length L2 of the accommodating recess **23***a* in the longitudinal direction of the heater holder **23** is slightly greater than a length L1 of the heater **22** in the longitudinal direction of the heater **22**. The accommodating recess **23***a* is thus slightly longer than the heater **22**. Accordingly, even when the heater **22** extends in the longitudinal direction of the heater **22** due to thermal expansion, the heater **22** does not interfere with the accommodating recess **23***a*. A connector serving as a power supplier sandwiches the heater holder **23** and the heater **22** accommodated in the accommodating recess **23***a*, thus holding the heater **22**. A detailed description of the connector is deferred.

Each of the supports **32** in pair includes a C-shaped belt support **32***b*, a belt restrictor **32***c*, and a supporting recess **32***d*. The belt support **32***b* is inserted into the loop formed by the fixing belt **20** to support the fixing belt **20**. The belt restrictor **32***c* is a flange that contacts an edge surface of the fixing belt **20** to restrict a longitudinal movement (e.g., skew) of the fixing belt **20**. The supporting recess **32***d* supports the heater holder **23** and the stay **24** with one longitudinal end side of each of the heater holder **23** and the stay **24** inserted into the supporting recess **32***d*. As the belt support **32***b* is inserted into the loop formed by the fixing belt **20** on each axial end side of the fixing belt **20**, the fixing belt **20** is supported by a free belt system in which the fixing belt **20** is not stretched basically in a circumferential direction of the fixing belt **20**, which is a rotation direction of the fixing belt **20**, while the fixing belt **20** does not rotate.

As illustrated in FIGS. **5** and **6**, a positioning recess **23***e* serving as a positioner is provided on one longitudinal end side of the heater holder **23**. An engagement **32***e* of the support **32** illustrated on the left side in FIGS. **5** and **6** engages the positioning recess **23***e*, thus positioning the heater holder **23** relative to the support **32** in the longitudinal direction of the fixing belt **20**. By contrast, the support **32** illustrated on the right side in FIGS. **5** and **6** does not include the engagement **32***e*. Therefore, the heater holder **23** is not positioned relative to the support **32** in the longitudinal direction of the fixing belt **20**. The heater holder **23** is thus positioned relative to the support **32** on a single side in the longitudinal direction of the fixing belt **20**. Such a configuration does not restrict thermal expansion or shrinkage of the heater holder **23** in the longitudinal direction of the fixing belt **20** caused by changes in temperature.

As illustrated in FIG. **6**, a step **24***a* is provided on each longitudinal end side of the stay **24** to restrict movement of the stay **24** relative to the support **32**. Specifically, the step **24***a* comes into contact with the support **32**, thus restricting a longitudinal movement of the stay **24** relative to the support **32**. Note that at least one of the steps **24***a* is arranged relative to the support **32** via a gap. Such an arrangement does not restrict thermal expansion or shrinkage of the stay **24** in the longitudinal direction of the fixing belt **20** caused by changes in temperature.

Referring now to FIGS. **7** and **8**, a detailed description is given of a configuration of the heater **22** incorporated in the heating device **19**.

FIG. **7** is a plan view of the heater **22**. FIG. **8** is an exploded perspective view of the heater **22**.

As illustrated in FIG. **8**, the heater **22** includes the base **50**, the first insulation layer **51** disposed on the base **50**, the conductor layer **52** disposed on the first insulation layer **51**, and the second insulation layer **53** that covers the conductor layer **52**.

The base **50** is an elongated plate made of metal such as stainless steel (e.g., SUS), iron, or aluminum. The base **50** may be made of ceramic or glass instead of metal. In a case in which the base **50** is made of an insulating material such as ceramic, the first insulation layer **51** sandwiched between the base **50** and the conductor layer **52** may be omitted. Since metal has an enhanced durability against rapid heating and is easy to process, metal is preferably used to reduce manufacturing costs. Among metals, aluminum and copper are preferable because aluminum and copper especially attain an increased thermal conductivity and barely suffer from unevenness in temperature. Stainless steel is advantageous because stainless steel is manufacturable at reduced costs compared to aluminum and copper.

Each of the first insulation layer **51** and the second insulation layer **53** is made of a material having insulating properties such as heat resistant glass. Alternatively, each of the first insulation layer **51** and the second insulation layer **53** may be made of, e.g., ceramic or PI.

The conductor layer **52** includes the heat generation unit **60**, a plurality of electrodes **61**, and a plurality of feed lines **62**. The heat generation unit **60** includes resistive heat generators **59** arranged in the longitudinal direction of the heater **22**. The plurality of feed lines **62** serves as a plurality of conductors that electrically connects the heat generation unit **60** and the plurality of electrodes **61**. In the present embodiment, the plurality of electrodes **61** includes a first electrode **61**A and a second electrode **61**B. The first electrode **61**A and the second electrode **61**B are arranged on opposed longitudinal end sides of the base **50**. The "end side" herein refers to one or another longitudinal end side of the base **50** rather than the heat generation unit **60**. The resistive heat generators **59** are arranged in a line in a longitudinal direction of the base **50** between the first electrode **61**A and the second electrode **61**B. In FIG. **7**, a "transverse direction" is a direction indicated by arrow Y intersecting the longitudinal direction (i.e., longitudinal direction U) of the heater **22** (or the base **50**) along a surface of the heater **22** on which the heat generation unit **60** is disposed. Hereinafter, the transverse direction is occasionally referred to as a transverse direction Y. When viewed in the transverse direction Y, each of the resistive heat generators **59** is interposed between a first feed line **62**A serving as a first conductor and a second feed line **62**B serving as a second conductor that extend in the longitudinal direction U of the heater **22**. In the present embodiment, each of the resistive heat generators **59** is shaped to reciprocate (or to be folded back) in the longitudinal direction U of the heater **22** via corner portions. A first end portion of each of the resistive heat generators **59** in the transverse direction Y of the heater **22** is connected to the first electrode **61**A through the first feed line **62**A. In other words, the first feed line **62**A is connected to the first end portion of each of the resistive heat generators **59** in the transverse direction Y of the heater **22** at a connecting position G**1**. A second end portion of each of the resistive heat generators **59** in the transverse direction Y of the heater **22** is connected to the second electrode **61**B through the second feed line **62**B. In other words, the second feed line **62**B is connected to the second end portion of each of the resistive heat generators **59** in the transverse direction Y of the heater **22** at a connecting position G**2**. Thus, the resistive heat generators **59** are connected in parallel with each other to the first electrode **61**A and the second electrode **61**B through the first feed line **62**A and the second feed line **62**B, respectively. In other words, the first feed line **62**A serving as a first conductor is configured to connect the resistive heat generators **59** in parallel with each other to the first electrode **61**A. The second feed line **62**B serving as a second conductor is configured to connect the resistive heat generators **59** in parallel with each other to the second electrode **61**B.

The resistive heat generators **59** are conductive parts having a resistance value greater than a resistance value of the feed lines **62**. The resistive heat generators **59** are formed by, for example, coating the base **50** with a paste of silver-palladium (AgPd), glass powder, and the like by screen printing and thereafter firing the coated base **50**. Alternatively, the resistive heat generators **59** may be made of a resistive material such as a silver alloy (AgPt) or ruthenium oxide (RuO_2).

The feed lines **62** are conductors having a resistance value smaller than the resistance value of the resistive heat generators **59**. The feed lines **62** and the electrodes **61** are made of, e.g., silver (Ag) or AgPd. The feed lines **62** and the electrodes **61** are formed by screen printing of such a material, for example.

Referring now to FIG. **9**, a description is given of a connector **70** that is coupled to the heater **22**.

FIG. **9** is a perspective view of the heater **22** and the connector **70** coupled to the heater **22**.

As illustrated in FIG. **9**, the connector **70** includes a housing **71** made of resin and a contact terminal **72** disposed in the housing **71**. The contact terminal **72** is a flat spring and coupled to a harness **73** that supplies power.

As illustrated in FIG. **9**, the connector **70** is attached to the heater **22** and the heater holder **23** such that a front side of the connector **70** sandwiches the heater **22** and the heater holder **23** together with a back side of the connector **70**. In this state, a contact **72***a* provided at an end of the contact terminal **72** resiliently contacts or presses against the electrode **61**. Accordingly, the heat generation unit **60** is electrically connected to a power supply disposed in the image forming apparatus **100** through the connector **70**, allowing the power supply to supply power to the heat generation unit **60**. Similarly, another connector **70** is connected to the electrode **61** located opposite the electrode **61** illustrated in FIG. **9** in the longitudinal direction of the heater **22**. Note that, as illustrated in FIG. **7**, at least part of each of the electrodes **61** is not coated by the second insulation layer **53** and therefore exposed to secure connection with the corresponding connector **70**.

In a typical heater including a base provided with a feed line, when power is supplied from a power supply to a resistive heat generator so that the resistive heat generator generates heat, the feed line is energized and generates heat. Such heat generation of the feed line affects a temperature distribution of the entire heater. However, the influences are changeable. The influences change depending on, e.g., the layout of the feed line or the connecting position of the feed line and the resistive heat generator.

Referring now to FIGS. **10**A to **11**B, a description is given of different influences of heat generation of the feed line, caused by different connecting positions of the feed line and the resistive heat generator.

FIG. **10**A illustrates a comparative heater **122** having a configuration different from the configuration of the aforementioned heater **22** according to an embodiment of the present disclosure. Specifically, FIG. **10**A is a plan view of the comparative heater **122**, illustrating the feed lines **62** connected to each of the resistive heat generators **59** on opposite sides of each of the resistive heat generators **59** in a longitudinal direction of the comparative heater **122**, with a table indicating the amounts of heat generated by the feed lines **62** for each block. FIG. **10**B is a graph illustrating the total amount of heat generated by the feed lines for each block.

The first feed line **62**A and the second feed line **62**B are connected to each of the resistive heat generators **59** at the connecting positions G**1** and G**2**, respectively. The connecting positions G**1** and G**2** are located on opposite sides (i.e., right side and left side in FIG. **10**A) with respect to a center M of each of the resistive heat generators **59** in the longitudinal direction U of the comparative heater **122**.

By contrast, FIG. **11**A illustrates the heater **22** according to an embodiment of the present disclosure. Specifically, FIG. **11**A is a plan view of the heater **22** of FIG. **7**, illustrating the feed lines **62** connected to each of the resistive heat generators **59** on one side of each of the resistive heat generators **59** in the longitudinal direction of the heater **22**, with a table indicating the amounts of heat generated by the feed lines **62** for each block. FIG. **11**B is a graph illustrating the total amount of heat generated by the feed lines **62** for each block.

The first feed line **62**A and the second feed line **62**B are connected to each of the resistive heat generators **59** at the connecting positions G**1** and G**2**, respectively. The connecting positions G**1** and G**2** are located on the same side (in this case, right side in FIG. **11**A) with respect to the center M of each of the resistive heat generators **59** in the longitudinal direction U of the heater **22**.

In the examples illustrated in FIGS. **10**A and **11**A, when the current flows to each of the resistive heat generators **59** by 20%, the amounts of heat generated by the feed lines **62** for each of first to fifth blocks corresponding to each of the resistive heat generators **59** are as indicated by the tables illustrated in FIGS. **10**A and **11**A, respectively.

Since a relatively small amount of heat is generated in a shorter portion of each of the feed lines **62** extending in a transverse direction of the comparative heater **122** and the heater **22**, the respective tables illustrated in FIGS. **10**A and **11**A simply indicate the calculated amounts of heat generated in a longer portion of each of the feed lines **62** extending in the longitudinal direction U of the comparative heater **122** and the heater **22**, excluding the amount of heat generated in the shorter portion. Specifically, in FIG. **10**A, calculated is the amount of heat generated in the longer portion of each of the first feed line **62**A located on an upper side in FIG. **10**A and the second feed line **62**B located on a lower side in FIG. **10**A extending in the longitudinal direction U of the comparative heater **122**. In FIG. **11**A, calculated is the amount of heat generated in the longer portion of each of the first feed line **62**A located on an upper side in FIG. **11**A and the second feed line **62**B located on a lower side in FIG. **11**A extending in the longitudinal direction U of the heater **22**. Since a heat generation amount (W) is represented by the following equation (1), the heat generation amount indicated in each of the tables of FIGS. **10**A and **11**A is calculated as the square of a current (I) flowing through each of the feed lines **62** for convenience. Therefore, the numerical values of the heat generation amount indicated in each of the tables of FIGS. **10**A and **11**A are merely values calculated simply and may be different from the actual heat generation amount.

$$W=R\times I^2, \tag{1}$$

where W represents the heat generation amount, R represents the resistance, and I represents the current.

With continued reference to FIG. **10**A, a description is given a specific way of calculating the heat generation amount for the first and second blocks, for example. In the first block of FIG. **10**A, the current flowing through the first feed line **62**A is 100% while the current flowing through the second feed line **62**B is 20%. Therefore, the total amount of heat generated by the feed lines **62** in the first block is 10400, which is the total value of the square of 100 (i.e., 10000) and the square of 20 (i.e., 400). In the second block of FIG. **10**A, the current flowing through the first feed line **62**A is 80% while the current flowing through the second feed line **62**B is 40%. Therefore, the total amount of heat generated by the feed lines **62** in the second block is 8000, which is the total value of the square of 80 (i.e., 6400) and the square of 40 (i.e., 1600).

The heat generation amounts are calculated similarly for the other blocks.

FIGS. **10**B and **11**B are graphs of the tables of FIGS. **10**A and **11**A, respectively, illustrating the total amount of heat generated by the feed lines **62**, in the vertical axis, for each of the first to fifth blocks. As is clear from the graph of FIG. **10**B, in a case in which the first feed line **62**A and the second feed line **62**B are connected to each of the resistive heat generators **59** at the connecting positions G**1** and G**2**, respectively, on the opposite sides in the longitudinal direction U of the comparative heater **122**, the total heat generation amounts for the first to fifth blocks are symmetric with respect to the third block located in a center of a heat generation span. By contrast, as is clear from the graph of FIG. **11**B, in a case in which the first feed line **62**A and the second feed line **62**B are connected to each of the resistive heat generators **59** at the connecting positions G**1** and G**2**, respectively, on the same side in the longitudinal direction U of the heater **22**, the total heat generation amounts for the first to fifth blocks are asymmetric with respect to the third block located in the center of the heat generation span.

In short, depending on whether the connecting positions G**1** and G**2** are located on different sides or the same side in the longitudinal direction U, the total heat generation amounts of the feed lines **62** are symmetric on the one hand and asymmetric on the other hand. As in the example illustrated in FIG. **10**B, in a case in which the amounts of heat generated by the feed lines **62** are symmetric, the temperature distribution of the comparative heater **122** is not asymmetric even when the influence of heat generation of the feed lines **62** affects the temperature distribution of the entire comparative heater **122**. By contrast, in a case in which the amounts of heat generated by the feed lines **62** are asymmetric as in the example illustrated in FIG. **11**B, the temperature distribution of the heater **22** may be asymmetric due to the influence of heat generation of the feed lines **62**. In particular, in a case in which the current flowing to resistive heat generators is increased to speed up an image forming apparatus, or in a case in which feed lines are thinned to downsize a heater in a transverse direction of the heater, the amount of heat generated by the feed lines increases. Therefore, a longitudinal unevenness in temperature (or unevenness in temperature distribution) of the heater becomes remarkable. An increased longitudinal unevenness in temperature of the heater causes unevenness in glossiness in a fixed image, leading to a deterioration in image quality. In addition to the aforementioned case in which the connecting positions G**1** and G**2** of all the resistive heat generators **59** and the first feed line **62**A and the second feed line **62**B, respectively, are located on the same side in the longitudinal direction U of the heater **22**, the amounts of heat generated by the feed lines **62** become asymmetric in a case in which the connecting positions G**1** and G**2** of at least one of the resistive heat generators **59** and the first feed line **62**A and the second feed line **62**B, respectively, are located on the same side in the longitudinal direction U of the heater **22**.

To prevent such a longitudinal unevenness in temperature of a heater, the following measures are taken in the present embodiment.

FIG. **12** is a cross-sectional plan view of the image forming apparatus **100**.

As illustrated in FIG. **12**, an airflow generator is disposed in the image forming apparatus **100**, as a cooler that cools the fixing device **9**. The airflow generator in the present embodiment is an exhaust fan **81** that discharges air out of the body **103** of the image forming apparatus **100**. In the present embodiment, intake ports **105** are provided on an upper side wall and a left side wall, respectively, of the body **103** in FIG. **12**. An exhaust port **107** is provided on a right side wall of the body **103** in FIG. **12**. The exhaust fan **81** is disposed closer to the exhaust port **107** than the fixing device **9**. In other words, the exhaust fan **81** is disposed closer to the exhaust port **107** than the heater **22**. When the exhaust fan **81** is driven, the outside air is sucked or taken in through the intake ports **105** and then discharged out through the exhaust port **107**. That is, the driven exhaust fan **81** generates an airflow from the intake ports **105** to the exhaust port **107** in the body **103** of the image forming apparatus **100**.

In addition, as illustrated in FIG. **12**, the device frame **40** of the fixing device **9** includes a plurality of ventilation holes **41**. Therefore, the air mainly taken in through the intake port **105** on the upper side in FIG. **12** passes through the ventilation holes **41** of the fixing device **9** and is discharged through the exhaust port **107**. Note that the ventilation holes **41** are open for ventilation and different from openings (namely, a sheet entrance and a sheet exit) through which the sheets P are conveyed and the holes into which positioning projections or bolts are inserted to attach the fixing device **9** to the body **103** of the image forming apparatus **100**. Further, in the present embodiment, a duct **83** is disposed between the ventilation holes **41** and the exhaust fan **81**, as a ventilation channel that guides an airflow from the ventilation holes **41** to the exhaust fan **81**.

As the air taken in through the intake ports **105** is susceptible to a heat source of, e.g., the fixing device **9** and increases in temperature while passing through the inside of the body **103** of the image forming apparatus **100**. Therefore, in general, the air discharged through the exhaust port **107** is higher in temperature than the air taken in through the intake ports **105**. In other words, the air taken in through the intake ports **105** is lower in temperature than the air discharged through the exhaust port **107**. In short, a cooling ability with the airflow to a side on which the air is taken in from the outside is greater than the cooling ability to a side on which the air is discharged to the outside.

Therefore, the longitudinal unevenness in temperature of the heater **22** is prevented by location of a longitudinal end side higher in temperature of the heater **22** on the side on which the cooling ability with the airflow is greater. For example, in regard to the aforementioned heater **22** illustrated in FIG. **11**A, the temperature is higher on a left end side of the heater **22** than the temperature on a right end side of the heater **22**. Therefore, the exhaust fan **81**, which is an airflow generator serving as a cooler, generates an airflow to the heater **22** left to right in FIG. **11**A or FIG. **12**, that is, from the left end side of the heater **22** higher in temperature to the right end side of the heater **22** lower in temperature. In other words, in FIG. **11**A or FIG. **12**, the left end side of the heater **22** higher in temperature is located on an upstream side of the airflow; whereas the right end side of the heater **22** lower in temperature is located on a downstream side of the airflow.

Referring now to FIGS. **13**A and **13**B, a description is given of a configuration of a heater **22**V as a variation of the heater **22** illustrated in FIG. **11**A.

FIG. **13**A is a plan view of the heater **22**V, illustrating the feed lines **62** connected to each of the resistive heat generators **59** on another side of each of the resistive heat generators **59**, opposite the aforementioned side of each of the resistive heat generators **59** illustrated in FIG. **11**A, in a longitudinal direction of the heater **22**V, with a table indicating the amounts of heat generated by the feed lines **62** for each block. FIG. **13**B is a graph illustrating the total amount of heat generated by the feed lines **62** for each block.

FIGS. **13**A and **13**B illustrate an example opposite the example illustrated in FIGS. **11**A and **11**B in the location of the connecting positions G**1** and G**2**. Specifically, in FIG. **13**A, the first feed line **62**A and the second feed line **62**B are connected to each of the resistive heat generators **59** on the left side with respect to the center M of the resistive heat generator **59** in the longitudinal direction U of the heater **22**V. That is, a longitudinal end side higher in temperature (i.e., higher-temperature side) of the heater **22**V is opposite the longitudinal end side higher in temperature (i.e., higher-temperature side) of the heater **22**. That is, in this case, the temperature is higher on a right end side of the heater **22**V than the temperature on a left end side of the heater **22**V in FIG. **13**A. Therefore, contrary to the example illustrated in FIG. **11**A, the exhaust fan **81** generates an airflow to the heater **22**V right to left in FIG. **13**A, that is, from the right end side of the heater **22**V to the left end side of the heater **22**V. In other words, in FIG. **13**A, the right end side of the heater **22**V higher in temperature is located on an upstream side of the airflow; whereas the left end side of the heater **22**V lower in temperature is located on a downstream side of the airflow.

In short, in a case in which the first feed line **62**A and the second feed line **62**B are connected to the resistive heat generator **59** on one longitudinal end side (herein serving as a first longitudinal end side) of the heater **22** from the center M of the resistive heat generator **59** in the longitudinal direction U of the heater **22**, the temperature is higher on another longitudinal end side (herein serving as a second longitudinal end side) of the heater **22** opposite the first longitudinal end side of the heater **22** than the temperature on the first longitudinal end side of the heater **22**. Therefore, a cooling ability of the cooler to the second longitudinal end side higher in temperature (i.e., higher-temperature side) of the heater **22** is greater than the cooling ability to the first longitudinal end side lower in temperature (i.e., lower-temperature side) of the heater **22**. Note that the "one end" or "one end portion" herein refers to any one of the opposed longitudinal end portions of the heater **22**.

As described above, the present embodiment enhances the cooling ability to the higher-temperature side of the heater **22**, thus preventing the longitudinal unevenness in temperature of the heater **22** and the fixing belt **20**. Accordingly, the present embodiment prevents defects such as the unevenness in glossiness, thus maintaining the image quality.

In order to effectively generate the airflow and enhance the cooling ability, as illustrated in FIG. **12**, the exhaust fan **81** is preferably disposed on a side closer to the exhaust port **107** from a center J of a heat generation span H, which is a longitudinal span of the heater **22** over which all the resistive heat generators **59** are disposed. In other words, the exhaust fan **81** is preferably disposed on a side in a first direction S**1** from the center J of the heat generation span H. Note that the first direction S**1** is a direction indicated by arrow S**1** from the left end side of the heater **22** higher in temperature to the right end side of the heater **22** lower in temperature in FIG. **12**. More preferably, the exhaust fan **81** is disposed on the side in the first direction S**1** from an end portion K**1** of the heat generation span H in the first direction S**1**.

In the image forming apparatus **100** having a layout as illustrated in FIG. **12**, an axial direction L of the exhaust fan **81** is parallel to the longitudinal direction U of the heater **22** or an axial direction V of the pressure roller **21** such that the exhaust fan **81** is disposed on or near an inner surface of the side wall provided with the exhaust port **107** to facilitate discharging of air through the exhaust port **107**.

In a case in which the exhaust fan **81** is hardly disposed such that the axial direction L of the exhaust fan **81** is parallel to the longitudinal direction U of the heater **22** or the axial direction V of the pressure roller **21** due to layout reasons, the axial direction L of the exhaust fan **81** may be inclined at an angle of $\pm\theta°$ with respect to the longitudinal direction U of the heater **22** or the axial direction V of the pressure roller **21**. However, if the inclination angle θ of the exhaust fan **81** is too large, the exhaust fan **81** might have difficulties in discharging the air through the exhaust port

107. To address such a situation, the inclination angle θ of the exhaust fan **81** is preferably within a range of ±60° (i.e., −60°≤θ≤+60°) with respect to the longitudinal direction U of the heater **22** or the axial direction V of the pressure roller **21**. More preferably, the inclination angle θ of the exhaust fan **81** is within a range of ±45° (i.e., −45°≤θ≤+45°) with respect to the longitudinal direction U of the heater **22** or the axial direction V of the pressure roller **21**, and even more preferably within a range of ±30° (i.e., −30°≤θ≤+30°) with respect to the longitudinal direction U of the heater **22** or the axial direction V of the pressure roller **21**.

Further, as illustrated in FIG. **12**, in the present embodiment, a space in which the exhaust fan **81** is disposed is communicated with a space in which a motor **35** is disposed as a drive source of each of the image forming units **1**Y, **1**M, **1**C, and **1**Bk. Accordingly, the exhaust fan **81** generates an airflow around the fixing device **9**, and also around the motor **35** for each of the image forming units **1**Y, **1**M, **1**C, and **1**Bk. As described above, the exhaust fan **81** that cools the fixing device **9** generates an airflow around another object to be cooled such as the motor **35** for each of the image forming units **1**Y, **1**M, **1**C, and **1**Bk, a power supply board, the developing device **4**, or the exposure device **6**. Accordingly, a dedicated exhaust fan is excludable for each object to be cooled. Thus, the image forming apparatus **100** is downsized and manufactured at reduced costs.

As illustrated in FIG. **12**, the ventilation holes **41** are preferably located on a side closer to the fixing belt **20** to a side closer to the pressure roller **21**, in the device frame **40** of the fixing device **9**. In other words, the ventilation holes **41** are preferably located closer to the fixing belt **20** than to the pressure roller **21**. Such a location effectively generates an airflow on the side closer to the fixing belt **20** on which the temperature is desirably equalized particularly in the longitudinal direction of the heater **22**, thus preventing the longitudinal unevenness in temperature of the heater **22** described above.

FIG. **14** is a cross-sectional side view of the fixing device **9**, illustrating a first example of location of a temperature sensor **34**.

As illustrated in FIG. **14**, the image forming apparatus **100** includes the temperature sensor **34** disposed at a position corresponding to (or opposite) the ventilation hole **41**, as a belt temperature detector that detects a temperature of the fixing belt **20**. Such a location of the temperature sensor **34** attains advantages described below. Note that the temperature sensor **34** may be either a non-contact sensor or a contact sensor.

In the fixing device **9**, as the sheet P is heated when passing through the fixing nip N, the water contained in the sheet P is released as water vapor. At this time, the water vapor adhering to a temperature detection part **34***a* of the temperature sensor **34** as water droplets may cause a temperature detection error. To address such a situation, the temperature sensor **34** is disposed opposite the ventilation hole **41** as in the example illustrated in FIG. **14**. Such a location of the temperature sensor **34** facilitates generation of an airflow around the temperature sensor **34** and prevents the water droplets from adhering to the temperature detection part **34***a*. Accordingly, the temperature detection error is less likely to occur. As the water droplets are prevented from adhering to the temperature detection part **34***a*, the temperature sensor **34** can be disposed at a position at which water droplets are likely to adhere to the temperature sensor **34**. Thus, the present embodiment enhances the layout flexibility. In addition, as the temperature sensor **34**, an inexpensive infrared temperature sensor of which the temperature detection accuracy is likely to decrease due to the attachment of water droplets is adoptable to reduce manufacturing costs. Examples of the inexpensive infrared temperature sensor include a non-contact (NC) sensor and a thermopile.

FIG. **15** is another cross-sectional side view of the fixing device **9**, illustrating a second example of location of the temperature sensor **34**.

Since the water droplets hardly adhere to the temperature sensor **34**, the temperature sensor **34** may be disposed at a position above the heater **22** in a gravity direction at which the temperature sensor **34** is susceptible to water vapor as illustrated in FIG. **15**. That is, even in a case in which an upper end of the temperature detection part **34***a* is located above an upper end of the heater **22** in the gravity direction, the temperature sensor **34** detects the temperature of the fixing belt **20** with accuracy provided that the temperature sensor **34** is disposed at a position corresponding to (or opposite) the ventilation hole **41**. In other words, the temperature sensor **34** disposed at such a position detects the temperature of the fixing belt **20** on an exit side of the fixing nip N at which the temperature increases. In short, the temperature sensor **34** detects a temperature rise of the fixing belt **20** with an enhanced accuracy.

FIG. **16** is a cross-sectional plan view of the image forming apparatus **100**, illustrating a first example of location of the temperature sensor **34** in the longitudinal direction of the heater **22**. FIG. **17** is another cross-sectional plan view of the image forming apparatus **100**, illustrating a second example of location of the temperature sensor **34** in the longitudinal direction of the heater **22**.

The temperature sensor **34** may be disposed on a side corresponding to the left end side of the heater **22** in the longitudinal direction of the heater **22** as illustrated in FIG. **16**. Alternatively, the temperature sensor **34** may be disposed on a side corresponding to the right end side of the heater **22**, which is opposite the left end side of the heater **22**, in the longitudinal direction of the heater **22** as illustrated in FIG. **17**.

As in the example illustrated in FIG. **16**, in a case in which the temperature sensor **34** is disposed on the side corresponding to the left end side of the heater **22** (in other words, the side in a second direction S**2** opposite the first direction S**1**) from the center J of the heat generation span H, the position of the temperature sensor **34** is relatively close to a high-temperature portion of the heater **22**. That is, the temperature sensor **34** easily detects the high-temperature portion of the fixing belt **20** and therefore detects an excessive temperature rise in advance. Accordingly, the safety is enhanced while the melting toner on the sheet P is prevented from adhering to a fixing rotator (in this case, the fixing belt **20**) at high temperatures. In other words, the occurrence of so-called high temperature offset is prevented.

On the other hand, as in the example illustrated in FIG. **17**, in a case in which the temperature sensor **34** is disposed on the side corresponding to the right end side of the heater **22** (in other words, the side in the first direction S**1**) from the center J of the heat generation span H, the position of the temperature sensor **34** is relatively close to a low-temperature portion of the heater **22**. That is, the temperature sensor **34** easily detects the low-temperature portion of the fixing belt **20**, thereby preventing the occurrence of so-called low temperature offset in which unmelted toner adheres to the fixing belt **20** because the heat amount is insufficient to melt the toner.

Referring now to FIG. **18**, a description is given of another embodiment of the present disclosure.

In the present embodiment, an intake fan **82** is disposed instead of the exhaust fan **81**.

FIG. **18** is a cross-sectional plan view of an image forming apparatus **100**A according to the present embodiment.

As illustrated in FIG. **18**, in the present embodiment, the intake fan **82** serving as a cooler (or an airflow generator) is disposed inside the body **103** of the image forming apparatus **100**A. Also, in the present embodiment, the intake port **105** is provided in a lower side wall of the body **103** in FIG. **18**; whereas the exhaust port **107** is provided in an upper side wall of the body **103** in FIG. **18**. The intake fan **82** is disposed closer to the intake port **105** than the fixing device **9**. In other words, the intake fan **82** is disposed closer to the intake port **105** than the heater **22**. As in the embodiment described above, the device frame **40** of the fixing device **9** is provided with the plurality of ventilation holes **41**. The duct **83** is disposed between the ventilation holes **41** and the intake fan **82** to guide an airflow from the intake fan **82** to the ventilation holes **41**.

In the present embodiment, the intake fan **82** is configured to generate an airflow from the intake port **105** to the exhaust port **107** to prevent the longitudinal unevenness in temperature of the heater **22** and the fixing belt **20**. In other words, the intake fan **82**, which is an airflow generator serving as a cooler, generates an airflow to the heater **22** left to right in FIG. **18**, that is, from the left end side of the heater **22** higher in temperature to the right end side of the heater **22** lower in temperature. In other words, in FIG. **18**, the left end side of the heater **22** higher in temperature is located on an upstream side of the airflow; whereas the right end side of the heater **22** lower in temperature is located on a downstream side of the airflow. Thus, the intake fan **82** effectively cools the higher-temperature side of the heater **22**.

As illustrated in FIG. **18**, the intake fan **82** is preferably disposed on a side closer to the intake port **105** from the center J of the heat generation span H. In other words, the intake fan **82** is preferably disposed on a side in the second direction S**2** from the center J of the heat generation span H. Note that the second direction S**2** is a direction indicated by arrow S**2** from the right end side of the heater **22** lower in temperature to the left end side of the heater **22** higher in temperature in FIG. **18**. More preferably, the intake fan **82** is disposed on the side in the second direction S**2** from an end portion K**2** of the heat generation span H in the second direction S**2**.

If the intake fan **82** is too close to the fixing device **9** or an internal frame **110** that supports the image forming units **1**Y, **1**M, **1**C, and **1**Bk, the fixing device **9** or the internal frame **110** resists an airflow generated by the intake fan **82**, thus hampering an effective airflow generation. In order to effectively generate an airflow, the intake fan **82** is preferably disposed at a position slightly apart from the internal frame **110** or the fixing device **9**. In the image forming apparatus **100**A having a layout as illustrated in FIG. **18**, the intake fan **82** effectively generates an airflow with the axial direction L of the intake fan **82** inclined at an angle of 45° with respect to the longitudinal direction U of the heater **22** or the axial direction V of the pressure roller **21**.

In a case in which the intake fan **82** is hardly disposed such that the axial direction L of the intake fan **82** is inclined at an angle of 45° with respect to the longitudinal direction U of the heater **22** or the axial direction V of the pressure roller **21** due to layout reasons, the axial direction L of the intake fan **82** may be inclined at an angle of 45°±θ° with respect to the longitudinal direction U of the heater **22** or the axial direction V of the pressure roller **21**. However, if the angle θ of the intake fan **82** is too large, the intake fan **82** might have difficulties in generating an airflow. To address such a situation, the angle θ is preferably within a range of ±60° (−60°≤θ≤+60°). More preferably, the angle θ is within a range of ±45° (i.e., −45°≤θ≤+45°), and even more preferably within a range of ±30° (i.e., −30°≤θ≤+30°).

Like the embodiment described above, in the present embodiment in which the intake fan **82** is disposed, the temperature sensor **34** disposed corresponding to (or opposite) the ventilation hole **41** (as illustrated in FIG. **14**) prevents water droplets from adhering to the temperature sensor **34**, and therefore prevents temperature detection errors, enhances the layout flexibility, and reduces manufacturing costs as an inexpensive temperature sensor is adoptable. In the present embodiment, the temperature sensor **34** can be disposed as in the examples illustrated in FIGS. **15** to **17**. The advantages attained by the locations of the temperature sensor **34** illustrated in FIGS. **15** to **17** in the present embodiment are substantially the same as the advantages described above, and therefore a redundant description is herein omitted.

As described above, according to the embodiments of the present disclosure, even in a case in which heat generation of the feed lines **62** causes a longitudinal unevenness in temperature of the heater **22**, the cooler (e.g., exhaust fan **81**, intake fan **82**) exhibits an enhanced cooling ability to the higher-temperature side of the heater **22**, thus addressing the longitudinal unevenness in temperature of the heater **22** and the fixing belt **20**. Accordingly, the embodiments prevent defects caused by the unevenness in temperature, such as the unevenness in glossiness, thus maintaining the image quality. Note that the embodiments are applicable to a case in which the connecting positions G**1** and G**2** of at least one of the resistive heat generators **59** and the first feed line **62**A and the second feed line **62**B, respectively, are located on the same side in the longitudinal direction U of the heater **22** or the heater **22**V, in addition to the aforementioned case in which the connecting positions G**1** and G**2** of all the resistive heat generators **59** and the first feed line **62**A and the second feed line **62**B, respectively, are located on the same side in the longitudinal direction U of the heater **22** illustrated in FIG. **11**A or the heater **22**V illustrated in FIG. **13**A.

Since the embodiments prevent such an unevenness in temperature, the current flowing to resistive heat generators can be increased to speed up an image forming apparatus. In addition, feed lines can be thinned to downsize a heater. In other words, even in a case in which the amount of heat generated by the feed lines becomes remarkable by an increased current flowing to the resistive heat generators or because the feed lines are thinned, the embodiments prevent the unevenness in temperature caused by the heat generation of the feed lines. Accordingly, at least one of the speeding up and downsizing of the image forming apparatus can be achieved.

Therefore, the embodiments attain a greater advantage when applied to a downsized heater, particularly to a heater downsized in a transverse direction of the heater.

FIG. **19** is a plan view of the heater **22**, illustrating a transverse dimension Q of the heater **22** and a transverse dimension R of the resistive heat generators **59**.

Specifically, in FIG. **19**, Q represents the transverse dimension of the heater **22** (or the base **50**); whereas R represents the transverse dimension of the resistive heat generators **59**. Note that the transverse direction of each of the heater **22** and the plurality of resistive heat generators **59** intersects the longitudinal direction of the heater **22** along the surface of the heater **22** on which the heat generation unit

60 is disposed. In a case in which the embodiments are applied to the heater **22** in which a ratio (R/Q) of the transverse dimension R of the resistive heat generators **59** to the transverse dimension Q of the heater **22** is not less than 25%, a greater advantage can be attained. Note that the transverse dimension R of the resistive heat generators **59** refers to a transverse dimension of the entire resistive heat generator **59**, not to a thickness of a linear portion of the resistive heat generator **59** folded back. In a case in which the embodiments are applied to the heater **22** having a ratio (R/Q) of not less than 40% in the transverse dimension, an even greater advantage can be attained.

Referring now to FIG. **20**, a description is given of a configuration of a heater **22**W as a variation of the heater **22** illustrated in FIG. **19**.

FIG. **20** is a plan view of the heater **22**W, illustrating a longitudinal dimension La of the heater **22**W, a transverse dimension Q of the heater **22**W, and a transverse dimension Wb of the feed lines **62**.

In the example illustrated in FIG. **19**, the base **50** of the heater **22** is a rectangle and therefore the transverse dimension Q of the heater **22** remains unchanged at any longitudinal position of the heater **22**. By contrast, in a case in which the base **50** has an uneven edge, the transverse dimension Q changes depending on the longitudinal position of the heater **22**. For example, as illustrated in FIG. **20**, a base **50**W has an uneven edge and therefore the transverse dimension Q of the heater **22**W changes depending on the longitudinal position of the heater **22**W. In such a case, the transverse dimension Q of the heater **22**W is a smallest dimension of the heater **22**W in the transverse direction Y within the heat generation span H of the heater **22**W over which all the resistive heat generators **59** are disposed.

The embodiments of the present disclosure are applicable to the heater **22** in which a ratio (Q/La) of the transverse dimension Q of the heater **22** to the longitudinal dimension La of the heater **22** is greater than 1.5% and less than 6%. The embodiments of the present disclosure are also applicable to the heater **22** in which a ratio (Wb/Q) of the transverse dimension Wb of one of the first feed line **62**A and the second feed line **62**B to the transverse dimension Q of the heater **22** is greater than 2% and less than 20%. Note that, in a case in which a longitudinal dimension of the base **50** changes depending on the portion, the longitudinal dimension La of the heater **22** is a largest dimension of the heater **22** in the longitudinal direction U. For example, as illustrated in FIG. **20**, a longitudinal dimension of the base **50**W changes depending on the portion and therefore the longitudinal dimension La of the heater **22**W is a largest dimension of the heater **22**W in the longitudinal direction U. The transverse dimension Wb of the one of the first feed line **62**A and the second feed line **62**B refers to a thickness of a linear portion of the one of the first feed line **62**A and the second feed line **62**B extending in the longitudinal direction U of the heater **22**, excluding a portion of the one of the first feed line **62**A and the second feed line **62**B bent in the transverse direction Y of the heater **22** to join the resistive heat generator **59**. In a case in which the thickness of the one of the first feed line **62**A and the second feed line **62**B changes depending on the longitudinal position of the heater **22**, such as the heater **22**W illustrated in FIG. **20**, the transverse dimension Wb of the one of the first feed line **62**A and the second feed line **62**B refers to a smallest transverse dimension of the one of the first feed line **62**A and the second feed line **62**B within the heat generation span H.

As described above, the embodiments of the present disclosure prevent a longitudinal unevenness in temperature of a heater in which feed lines are connected to a resistive heat generator on one side in a longitudinal direction of the heater. Accordingly, such a heater can be positively adopted with the connecting positions of the feed lines and the resistive heat generator located on the same side in the longitudinal direction of the heater. As a consequence, the following advantages can be attained.

FIG. **21** is a schematic cross-sectional view of the fixing device **9**, illustrating a temperature sensor **44** (i.e., heater temperature sensor) provided for the heater **22**.

In general, a fixing device having a planar heater includes a heater temperature detector to detect a temperature of the heater. In the example illustrated in FIG. **21**, the temperature sensor **44** serves as a heater temperature detector that detects the temperature of the heater **22**. The temperature sensor **44** is, e.g., a thermistor. The temperature sensor **44** contacts, e.g., a back surface of the heater **22** opposite the surface on which the heat generation unit **60** is disposed, to detect the temperature of the heater **22**. According to the detected temperature of the heater **22**, the temperature of the heater **22** or the fixing belt **20** is controlled. In general, the heater **22** has a higher temperature on a center side of the heat generation unit **60** in the transverse direction Y of the heater **22** than a temperature on an end side of the heat generation unit **60** in the transverse direction Y of the heater **22**. In order to prevent overheating of the heater **22** in advance, the temperature sensor **44** is disposed at a position corresponding to a center F of the heat generation unit **60** in the transverse direction Y of the heater **22**. Hereinafter, the position corresponding to the center F is simply referred to as a “transverse center position” or a “transverse center position F.”

Referring now to FIGS. **22** and **23**, a description is given of the relative positions of the temperature sensor **44** and the comparative heater **122**.

FIG. **22** is a schematic view of the comparative heater **122** of FIG. **10**A, illustrating the feed lines **62** connected to each of the resistive heat generators **59** on the opposite sides of each of the resistive heat generators **59** in the longitudinal direction of the comparative heater **122**, with a location of the temperature sensor **44** (i.e., heater temperature sensor) in the transverse direction of the comparative heater **122**. FIG. **23** is a graph of a temperature distribution of the comparative heater **122** in an I-I cross section of FIG. **22**, with a cross-sectional view of the comparative heater **122** along a line I.

In the comparative heater **122** with the first feed line **62**A and the second feed line **62**B connected to each of the resistive heat generators **59** at the connecting positions G**1** and G**2**, respectively, on the opposite sides in the longitudinal direction U of the comparative heater **122** as illustrated in FIG. **22**, one of folded linear portions of each of the resistive heat generators **59** is located at the transverse center position F of the heat generation unit **60**. Therefore, in a case in which the temperature sensor **44** is disposed at the transverse center position F of the heat generation unit **60** as described above, a temperature detection part **44***a* of the temperature sensor **44** is located on the resistive heat generator **59** at the transverse center position F of the heat generation unit **60**. Note that the term “on the resistive heat generator” as used herein refers to a position overlapping the resistive heat generator **59** in a thickness direction, which is a direction intersecting the longitudinal direction U and the transverse direction Y of the heater **22** (or the comparative heater **122**).

In this case, as illustrated in FIG. **23**, a highest peak value is a temperature at the transverse center position F of the heat generation unit **60** at which the resistive heat generator **59** is located. The temperature sensor **44** detects the temperature of the peak value. However, since the temperature of the comparative heater **122** greatly changes in a very narrow range near the peak value, the detected temperature might greatly change if the temperature sensor **44** is slightly displaced in the transverse direction Y of the comparative heater **122**, hampering an appropriate detection of the temperature of the comparative heater **122**.

Referring now to FIGS. **24** and **25**, a description is given of the relative positions of the temperature sensor **44** and the heater **22**.

FIG. **24** is a schematic view of the heater **22** of FIG. **7**, illustrating the feed lines **62** connected to each of the resistive heat generators on one side in the longitudinal direction of the heater **22**, with a location of the temperature sensor **44** (i.e., heater temperature sensor) in the transverse direction of the heater **22**. FIG. **25** is a graph of a temperature distribution of the heater **22** in a II-II cross section of FIG. **24**, with a cross-sectional view of the heater **22** along a line II.

Contrary to the comparative heater **122** described above with reference to FIGS. **22** and **23**, in the heater **22** with the first feed line **62**A and the second feed line **62**B connected to each of the resistive heat generators **59** at the connecting positions G**1** and G**2**, respectively, on the same side in the longitudinal direction U of the heater **22** as illustrated in FIG. **24**, the temperature detection part **44***a* is located not on the resistive heat generator **59** but at a position corresponding to an interval between longitudinal portions of the resistive heat generator **59** extending in the longitudinal direction U of the heater **22**. In other words, the temperature detection part **44***a* is located at a position corresponding to a portion of the heater **22** without the resistive heat generator **59**. Note that the term "position corresponding to an interval between longitudinal portions of the resistive heat generator **59** extending in the longitudinal direction U of the heater **22**" as used herein refers to a position overlapping, in the thickness direction of the heater **22**, a position in an interval between the longitudinal portions of the resistive heat generator **59** extending in the longitudinal direction U of the heater **22**.

In this case, as illustrated in FIG. **25**, the temperature sensor **44** detects a temperature between adjacent peak values of the heater **22**. Since the temperature changes gently in a relatively wide range between the adjacent peak values, the detected temperature is unlikely to change even if the temperature sensor **44** is displaced in the transverse direction Y of the heater **22**. Therefore, this case has an advantage in reducing differences in detected temperature caused by the displacement of the temperature sensor **44**. Since the displacement of the temperature sensor **44** unlikely causes the differences in detected temperature, the temperature sensor **44** does not have to be installed with high accuracy. That is, the workability of installing the temperature sensor **44** is enhanced.

Note that, as in the heater **22** illustrated in FIG. **24**, the temperature detection part **44***a* may be located between adjacent peak values in the comparative heater **122** illustrated in FIG. **22**. However, in such a case, the adjacent peak values are different from each other in height (i.e., temperature) as illustrated in FIG. **23**. Therefore, the amount of change in detected temperatures depends on which peak value the temperature sensor **44** is displaced to. From the viewpoint of reducing the differences in detected temperature, the configuration in which the connecting positions of the feed lines and the resistive heat generator are located on the same side in the longitudinal direction of the heater is preferable to the configuration in which the connecting positions of the feed lines and the resistive heat generator are located on the opposite sides in the longitudinal direction of the heater.

Compared to the comparative heater **122** in which the first feed line **62**A and the second feed line **62**B are connected to the resistive heat generator **59** on the opposite sides in the longitudinal direction of the comparative heater **122**, the heater **22** in which the first feed line **62**A and the second feed line **62**B are connected to the resistive heat generator **59** on the same side in the longitudinal direction of the heater **22** has an advantage in arrangement of the temperature sensor **44** in the transverse direction Y of the heater **22**.

Moreover, it is desirable to pay attention to the following points when disposing the temperature sensor **44** in the longitudinal direction U of the heater **22**.

FIG. **26** is a schematic view of the heater **22**, illustrating a location of the temperature sensor **44** (i.e., heater temperature sensor) in the longitudinal direction U of the heater **22**.

As illustrated in FIG. **26**, in the present embodiment, opposed end portions of each of the resistive heat generators **59** in the longitudinal direction U of the heater **22** are inclined with respect to a sheet conveyance direction (i.e., vertical direction in FIG. **26**), which is a direction in which the sheet P is conveyed. At least part of the respective end portions of the adjacent resistive heat generators **59** overlap each other in the longitudinal direction U of the heater **22**. That is, at least part of the end portions of the adjacent resistive heat generators **59** are located in a common area Z in the longitudinal direction U of the heater **22**. Specifically, the resistive heat generator **59** includes an overlapping portion **59***a* and a non-overlapping portion **59***b*. The overlapping portion **59***a* is located in the common area Z shared with the adjacent resistive heat generator **59** in the longitudinal direction U of the heater **22**. By contrast, the non-overlapping portion **59***b* is not located in the common area Z shared with the adjacent resistive heat generator **59** in the longitudinal direction U of the heater **22**.

The overlapping portion **59***a* reduces a temperature decrease between the adjacent resistive heat generators **59**. However, compared to the non-overlapping portion **59***b*, the overlapping portion **59***a* tends to have greater temperature differences determined by position. Therefore, as illustrated in FIG. **26**, the temperature detection part **44***a* of the temperature sensor **44** is preferably located at a position corresponding to the non-overlapping portion **59***b*, not to the overlapping portion **59***a*. Note that the term "position corresponding to the non-overlapping portion **59***b*" herein refers to a position overlapping the non-overlapping portion **59***b* in the thickness direction of the heater **22**.

In the embodiments of the present disclosure, a resistive heat generator having a positive temperature coefficient (PTC) characteristic may be used to further prevent the longitudinal unevenness in temperature of the heater **22**. The PTC characteristic is a characteristic in which the resistance value increases as the temperature increases, for example, a heater output decreases under a given voltage. The heat generation unit **60** having the PTC characteristic starts up quickly with an increased output at low temperatures and prevents overheating with a decreased output at high temperatures. For example, with a temperature coefficient of resistance (TCR) of the PTC characteristic in a range of from about 300 ppm/° C. to about 4,000 ppm/° C., the heater **22** is manufactured at reduced costs while retaining a sufficient resistance value for the heater **22**. The TCR is preferably in a range of from about 500 ppm/° C. to about 2,000 ppm/° C.

The TCR can be calculated using the following equation (2). In the equation (2), T0 represents a reference temperature, T1 represents a freely selected temperature, R0 represents a resistance value at the reference temperature T0, and R1 represents a resistance value at the selected temperature T1. For example, in the heater 22 described above with reference to FIG. 7, the TCR is 2,000 ppm/° C. from the equation (2) when the resistance values between the first electrode 61A and the second electrode 61B are 10Ω (i.e., resistance value R0) and 12Ω (i.e., resistance value R1) at 25° C. (i.e., reference temperature T0) and 125° C. (i.e., selected temperature T1), respectively.

$$TCR=(R1-R0)/R0/(T1-T0)\times 10^6 \quad (2)$$

Referring now to FIGS. 27 to 30, a description is given of some variations of the heater 22 illustrated in FIG. 7.

In the embodiments described above, a description has been given of the heater 22 that causes the resistive heat generators 59 to generate heat at the same time. The embodiments are also applicable to a heater including resistive heat generators 59 that are separately controllable to generate heat as illustrated in FIG. 27.

Referring now to FIG. 27, a description is given of a configuration of a heater 22A as a first variation of the heater 22 illustrated in FIG. 7.

FIG. 27 is a plan view of the heater 22A.

In the example illustrated in FIG. 27, a first heat generation group 60A and a second heat generation group 60B are separately controllable to generate heat. Specifically, the first heat generation group 60A is a first group of the resistive heat generators 59, which are other than the end resistive heat generators 59 (i.e., the resistive heat generators 59 arranged on the ends in the longitudinal direction U of the heater 22A) of the plurality of resistive heat generators 59. The second heat generation group 60B is a second group of the end resistive heat generators 59. Each of the resistive heat generators 59 of the first heat generation group 60A is connected to the first electrode 61A and the second electrode 61B through the first feed line 62A and the second feed line 62B, respectively. Each of the resistive heat generators 59 of the second heat generation group 60B is connected to the second electrode 61B through the second feed line 62B. Each of the resistive heat generators 59 of the second heat generation group 60B is also connected to a third electrode 61C through a third feed line 62C or a fourth feed line 62D.

When a voltage is applied to the first electrode 61A and the second electrode 61B, the resistive heat generators 59 other than the end resistive heat generators 59 are energized. Accordingly, the first heat generation group 60A generates heat alone. By contrast, when a voltage is applied to the first electrode 61A and the third electrode 61C, the end resistive heat generators 59 are energized. Accordingly, the second heat generation group 60B generates heat alone. When a voltage is applied to all the first to third electrodes 61A to 61C, the resistive heat generators 59 of both the first heat generation group 60A and the second heat generation group 60B (i.e., all the resistive heat generators 59) generate heat.

In such a configuration in which two heat generation groups (or groups of resistive heat generators), namely the first heat generation group 60A and the second heat generation group 60B, are separately controllable to generate heat, the aforementioned longitudinal unevenness in temperature of the heater 22A may occur as the feed lines 62 are connected to each of the resistive heat generators 59 at the connecting positions G1 and G2, respectively, on the same side with respect to the center M of each of the resistive heat generators 59 in the longitudinal direction U of the heater 22A. For example, when the first heat generation group 60A generates heat, the first feed line 62A and the second feed line 62B are energized and generate heat, causing the longitudinal unevenness in temperature of the heater 22A. The embodiments of the present disclosure prevent a longitudinal unevenness in temperature of the heater 22A having the configuration described above.

In the embodiments described above, either the exhaust fan 81 or the intake fan 82 is used as a cooler to prevent the longitudinal unevenness in temperature of the heater 22. Alternatively, both the exhaust fan 81 and the intake fan 82 may be used as coolers to prevent the longitudinal unevenness in temperature of the heater 22. Alternatively, a cooler other than the exhaust fan 81 or the intake fan 82 may be used.

Referring now to FIG. 28, a description is given of a configuration of a heater 22B as a second variation of the heater 22 illustrated in FIG. 7.

FIG. 28 is a plan view of the heater 22B.

In the embodiments described above, each of the first feed line 62A and the second feed line 62B has a transverse portion extending in the transverse direction Y of the heater 22 as illustrated in FIG. 7 and connected to each of the resistive heat generators 59. However, the transverse portion that connects each of the first feed line 62A and the second feed line 62B to each of the resistive heat generators 59 is not limited to a part of each of the first feed line 62A and the second feed line 62B. Alternatively, as in the example illustrated in FIG. 28, the transverse portion may be a part of each of the resistive heat generators 59.

Referring now to FIGS. 29 and 30, a description is given of a configuration of a heater 22C as a third variation of the heater 22 illustrated in FIG. 7 and a configuration of a heater 22D as a fourth variation of the heater 22 illustrated in FIG. 7, respectively.

FIG. 29 is a plan view of the heater 22C. FIG. 30 is a plan view of the heater 22D.

In the embodiments described above, each of the resistive heat generators 59 is turned a plurality of times. In other words, each of the resistive heat generators 59 has a plurality of corner portions. Alternatively, the number of turns (i.e., the number of corner portions) of each of the resistive heat generators 59 may be one as illustrated in FIGS. 29 and 30. Each of the connecting position G1 of the first feed line 62A and each of the resistive heat generators 59 and the connecting position G2 of the second feed line 62B and each of the resistive heat generators 59 may be a corner of an end portion of each of the resistive heat generators 59 as illustrated in FIG. 29. Alternatively, as illustrated in FIG. 30, each of the connecting positions G1 and G2 may be an entire edge, extending in the transverse direction Y, of the end portion of each of the resistive heat generators 59.

The embodiments of the present disclosure are also applicable to fixing devices as illustrated in FIGS. 31 to 33, respectively, other than the fixing device 9 described above.

Referring now to FIGS. 31 to 33, a description is given of some variations of the fixing device 9.

Initially with reference to FIG. 31, a description is given of a configuration of a fixing device 9A as a first variation of the fixing device 9.

FIG. 31 is a cross-sectional view of the fixing device 9A.

As illustrated in FIG. 31, the fixing device 9A includes a pressing roller 90 disposed opposite the pressure roller 21 via the fixing belt 20. The heater 22 sandwiches the fixing belt 20 together with the pressing roller 90 to heat the fixing belt 20. On the other hand, a nip formation pad 91 is disposed inside the loop formed by the fixing belt 20 and opposite the pressure roller **21**. The stay **24** supports the nip formation pad **91**. The nip formation pad **91** sandwiches the fixing belt **20** together with the pressure roller **21** to form the fixing nip N between the fixing belt **20** and the pressure roller **21**.

Referring now to FIG. **32**, a description is given of a configuration of a fixing device **9**B as a second variation of the fixing device **9**.

FIG. **32** is a cross-sectional view of the fixing device **9**B.

As illustrated in FIG. **32**, the fixing device **9**B does not include the pressing roller **90** described above with reference to FIG. **31**. In order to attain a contact length for which the heater **22** contacts the fixing belt **20** in the circumferential direction of the fixing belt **20**, the heater **22** is curved into an arc in cross section conforming to a curvature of the fixing belt **20**. The rest of the configuration of the fixing device **9**B is substantially the same as the rest of the configuration of the fixing device **9**A described above with reference to FIG. **31**.

Referring now to FIG. **33**, a description is given of a configuration of a fixing device **9**C as a third variation of the fixing device **9**.

FIG. **33** is a cross-sectional view of the fixing device **9**C.

As illustrated in FIG. **33**, the fixing device **9**C includes a pressure belt **92** in addition to the fixing belt **20**. The pressure belt **92** and the pressure roller **21** form a fixing nip N2 serving as a secondary nip separately from a heating nip N1 serving as a primary nip formed between the fixing belt **20** and the pressure roller **21**. Specifically, the nip formation pad **91** and a stay **93** are disposed opposite the fixing belt **20** via the pressure roller **21**. The pressure belt **92** is rotatably disposed while accommodating the nip formation pad **91** and the stay **93**. As a sheet P bearing a toner image is conveyed through the fixing nip N2 formed between the pressure belt **92** and the pressure roller **21**, the pressure belt **92** and the pressure roller **21** fix the toner image onto the sheet P under heat and pressure. The rest of the configuration of the fixing device **9**C is substantially the same as the rest of the configuration of the fixing device **9** described above with reference to FIG. **2**.

The image forming apparatus incorporating the fixing device according to an embodiment described above is not limited to a color image forming apparatus as illustrated in FIG. **1**. Alternatively, the image forming apparatus may be a monochrome image forming apparatus that forms a monochrome toner image on a recording medium. In addition, the image forming apparatus to which the embodiments of the present disclosure are applied includes, but is not limited to, a printer, a copier, a facsimile machine, or a multifunction peripheral having at least two capabilities of these devices. In addition to the electrophotographic image forming apparatus incorporating the fixing device as described above, the embodiments of the present disclosure are applicable to an inkjet image forming apparatus including a drying device that dries ink applied to a sheet. The embodiments of the present disclosure are also applicable to a heat press machine including a heat press part that heats and presses a target object, such as a laminator that heats and presses a film as a covering material on a surface of a sheet such as paper or a heat sealer that heats and presses a sealing part of a packaging material. Such an inkjet image forming apparatus and a heat press machine to which an embodiment of the present disclosure is applied prevent a longitudinal unevenness in temperature of a heater and cope with downsizing and increase in speed.

According to the embodiments described above, the unevenness in temperature of a heater is prevented.

Although the present disclosure makes reference to specific embodiments, it is to be noted that the present disclosure is not limited to the details of the embodiments described above. Thus, various modifications and enhancements are possible in light of the above teachings, without departing from the scope of the present disclosure. It is therefore to be understood that the present disclosure may be practiced otherwise than as specifically described herein. For example, elements and/or features of different embodiments may be combined with each other and/or substituted for each other within the scope of the present disclosure. The number of constituent elements and their locations, shapes, and so forth are not limited to any of the structure for performing the methodology illustrated in the drawings.

What is claimed is:

1. An image forming apparatus comprising:
- a heater including:
  - a heat generation unit including resistive heat generators arranged in a longitudinal direction of the heater;
  - a first electrode;
  - a second electrode;
  - a first conductor configured to connect the resistive heat generators;
  - a second conductor configured to connect the resistive heat generators;
  - the first conductor and the second conductor connected to at least one resistive heat generator of the resistive heat generators on a longitudinal end side of the resistive heat generator in the longitudinal direction of the heater,
  - a heater temperature detector configured to detect a temperature of the heater,
  - wherein the resistive heat generators are shaped to reciprocate in the longitudinal direction of the heater via a corner portion, and
  - wherein the heater temperature detector is disposed at a position corresponding to an interval between longitudinal portions of the resistive heat generator extending in the longitudinal direction of the heater,
  - wherein the heat generation unit is configured to generate heat asymmetrically in the longitudinal direction.

2. The image forming apparatus according to claim **1**,
- wherein the resistive heat generators include an adjacent resistive heat generator adjacent to the at least one resistive heat generator,
- wherein the resistive heat generators include:
  - an overlapping portion located in a common area shared with the adjacent resistive heat generator in the longitudinal direction of the heater; and
  - a non-overlapping portion not located in the common area shared with the adjacent resistive heat generator in the longitudinal direction of the heater, and
- wherein the heater temperature detector is disposed at a position corresponding to the non-overlapping portion.

3. The image forming apparatus according to claim **1**,
- wherein a ratio of a transverse dimension of the heater to a longitudinal dimension of the heater is greater than 1.5% and less than 6%, and
- wherein a transverse direction of the heater intersects the longitudinal direction of the heater along a surface of the heater on which the heat generation unit is disposed.

4. The image forming apparatus according to claim **1**,
- wherein a ratio of a transverse dimension of one of the first conductor and the second conductor to a transverse dimension of the heater is greater than 2% and less than 20%, and

wherein a transverse direction of each of the heater and the one of the first conductor and the second conductor intersects the longitudinal direction of the heater along a surface of the heater on which the heat generation unit is disposed.

5. The image forming apparatus according to claim **1**,

wherein a ratio of a transverse dimension of the resistive heat generators to a transverse dimension of the heater is not less than 25%, and

wherein a transverse direction of each of the heater and the resistive heat generators intersects the longitudinal direction of the heater along a surface of the heater on which the heat generation unit is disposed.

6. The image forming apparatus according to claim **1**,

wherein a ratio of a transverse dimension of the resistive heat generators to a transverse dimension of the heater is not less than 40%, and

wherein a transverse direction of each of the heater and the resistive heat generators intersects the longitudinal direction of the heater along a surface of the heater on which the heat generation unit is disposed.

7. The image forming apparatus according to claim **1**, further includes

a cooler to cool the heater,

wherein the cooler includes an airflow generator, and

wherein the airflow generator is configured to generate an airflow to the heater.

8. The image forming apparatus according to claim **7**, further

comprising:

a device frame configured to support the heater,

the device frame having a ventilation hole; and

a ventilation channel disposed between the airflow generator and the ventilation hole to guide the airflow.

9. The image forming apparatus according to claim **8**, further

comprising:

an endless belt configured to contact the heater; and

an opposed rotator configured to contact the endless belt to form a fixing nip between the endless belt and the opposed rotator,

wherein the ventilation hole is located closer to the endless belt than to the opposed rotator.

10. The image forming apparatus according to claim **9**, further

comprising a belt temperature detector disposed opposite the ventilation hole to detect a temperature of the endless belt.

11. The image forming apparatus according to claim **10**,

wherein the belt temperature detector includes a temperature detection part, and wherein an upper end of the temperature detection part is located above an upper end of the heater in a gravity direction.

12. The image forming apparatus according to claim **10**, wherein the heater temperature detector is on a side of the heater opposite the resistive heat generators.

13. The image forming apparatus according to claim **10**, wherein the heater temperature detector includes a temperature detection part facing the heater and a body supporting the temperature detection part.

14. The image forming apparatus according to claim **7**, further comprising

a body having an intake port configured to take in air from outside and an exhaust port configured to exhaust the air outside,

wherein the airflow generator is an exhaust fan disposed closer to the exhaust port than the heater, and

wherein an axial direction of the exhaust fan is inclined at an angle within a range of ±60° with respect to the longitudinal direction of the heater.

15. The image forming apparatus according to claim **7**, further comprising

a body having an intake port configured to take in air from outside and an exhaust port configured to exhaust the air outside,

wherein the airflow generator is an intake fan disposed closer to the intake port than the heater, and

wherein an axial direction of the intake fan is inclined at an angle within a range of 45°±60° with respect to the longitudinal direction of the heater.

16. An image forming apparatus comprising:

an airflow generator configured to generate an airflow;

a heater including:

a heat generation unit including resistive heat generators arranged in a longitudinal direction of the heater;

a first electrode;

a second electrode;

a first conductor configured to connect the resistive heat generators in parallel with each other to the first electrode;

a second conductor configured to connect the resistive heat generators in parallel with each other to the second electrode,

the first conductor and the second conductor connected to at least one resistive heat generator of the resistive heat generators on a longitudinal end side of the resistive heat generator in the longitudinal direction of the heater,

and

a heater temperature detector configured to detect a temperature of the heater,

wherein the resistive heat generators are shaped to reciprocate in the longitudinal direction of the heater via a corner portion, and

wherein the heater temperature detector is disposed at a position corresponding to an interval between longitudinal portions of the resistive heat generator extending in the longitudinal direction of the heater,

wherein the heat generation unit is configured to generate heat asymmetrically in the longitudinal direction.

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